ASSESSMENT OF THE INTERLINKAGES BETWEEN COASTAL FLOODING, EROSION AND CULTURAL ECOSYSTEM SERVICES IN ADA, GHANA

BY

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DECLARATION

Except where otherwise indicated, this thesis is my own work conducted under the supervision of Professor Kwasi Appeaning Addo, Dr. Adelina Mensah and Dr. Edem Mahu of the University of Ghana, Legon. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree.

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To Oger, Jean-Olympio and Liteila

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ABSTRACT

Cultural ecosystem services (non-material benefits that are derived from ecosystems that are derived from coastal systems are increasingly reducing due to ecological changes that are occurring within the coastal environment. Understanding the dynamics of these changes and their implications for sustainable coastal environmental management is imperative. Cultural ecosystem services in coastal areas are affected by several factors such as erosion, saline intrusion, loss of place and coastal flooding. Coastal flooding along the coast of Ghana has led to significant damage to properties and livelihoods with negative social consequences. However, various ways in which coastal flooding affects cultural ecosystem services is yet to be fully understood. This thesis assesses the interlinkages between coastal erosion, coastal flooding and cultural ecosystem services in Ada along the eastern coast of Ghana. Firstly, assessed community perceptions of the drivers of coastal flooding, assessed the status of ecosystems services and predicted the future implications of flooding on cultural ecosystem services in Ada.

Quantitative and qualitative data was collected from 358 respondents in seven communities in the Ada East and Ada West Districts of the Greater Accra Region. Perceptions of the drivers of flooding among community residents in Ada were investigated and compared to data on the drivers of flooding from 1985 to 2017. Structural Equation Model (SEM), a confirmatory analysis tool, was used to validate the relationship between the latent variable flooding and various categories of drivers.

The results showed that the drivers of flooding in Ada are both climatic and anthropogenic with climatic drivers being dominant. Three cultural ecosystems services identified in Ada which were

Place, Aesthetics and Recreation. Cultural livelihood was discovered as new cultural ecosystem service which expands the suite of cultural ecosystem services further. Extensive flooding has resulted in loss of place (physical, cultural and even imaginary location that is differentiated and emotionally meaningful to people), vegetation degradation and deterioration of landscape. The path analysis results indicate that the effect of flooding is a significant predictor of place with a coefficient of 0.015 and a p-value of 0.01. In addition, the mediation effect of flooding is a statistically significant predictor of cultural livelihood and recreation (p-values 0.00 and 0.05, respectively), but an insignificant predictor of aesthetic (p-value -0.02).

Results from the Bayesian network model, climatic drivers including sea level rise, rainfall, wave and wind speeds, present severe threats to the coastal dwellers of Ada East and West Districts. Currently, cultural ecosystem services are impacted. The model predicts that an increase in intensity of climatic drivers from 38.7% to 80% is likely to increase flood incidence from 42.1% to 58.3%. An increase in the intensity of non-climatic drivers also by 80% is likely to increase flood incidence by to 44.5% from the current level of 42.1%. This shows that relative to climatic drivers, non-climatic drivers have less impact on flooding in Ada. Cultural ecosystem services which local people depend on will decline significantly from 44.6% poor to 54.3% poorer. With adequate policy interventions such as provision of alternative livelihood support, construction of landing beaches and involvement of local people in the design of policies to address coastal flooding, the model predicts an improvement in ecosystem health from 36.7% to 48.5%. This implies that policy intervention should be more aligned towards measures to reduce the intensity of climatic drivers while maintaining anthropogenic drivers at their current levels.

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CHAPTER ONE

1. Introduction

1.1 Background to the Study

The Coast provides important social, cultural, and economic benefits for many communities around the world. There is no single definition for Coast (Wong et al., 2014), however it generally includes both natural coastal ecosystems that have distinct coastal features such rocky coasts, beaches, barriers and sand dunes, estuaries and lagoons, deltas, river mouths, wetlands, and coral reefs, as well as human systems such human environed units, interactions and transactions between and within the components. About 40% of the world's population lives within approximately 100 kilometers of the coast and about 75% of the world's cities are situated within coastal zones (Rajendran et al., 2017). Thirty seven percent of world's population live in coastal communities and depend on oceans, coastal and marine resources (Rajendran et al., 2017).

Coastal ecosystems link with other terrestrial systems such as freshwater ecosystems and marine ecosystems to promote stabilization of imbalances with any of the other systems (Wong et al., 2014). Benefits of coastal ecosystems include food supply from fishing and other benefits from activities such as salt mining, tourism and oil production. The coast provides both local communities and national economies with commercial benefits of fisheries. In the United States of America, the fisheries sector provided employment to about three million people and contributed about US$352 billion to the country's GDP in 2014 (National Oceanic and Atmospheric Administration, 2018). Fisheries and aquaculture is a source of livelihood to about 820 million people worldwide (FAO, 2020). The coast also provides recreational benefits to locals and tourists such as sightseeing, photography and wildlife viewing. Many communities that live along the coast have evolved cultures and traditions around surrounding ecosystems, which have defined their identities and way of living. For example in western part of Ghana for example, the people of Nzulezu in their traditional village life have adapted to the watery conditions living in stilted homes and platforms on the Lake Tadane and activities pertaining to normal life such as cooking, schooling, worship and burial are done on the lake (Ghana Museums and Monuments Board Government of the Republic of Ghana, 2000). Coastal ecosystems also contribute to carbon sequestration and storage, erosion prevention, waste-water treatment and moderation of extreme events (Ocean and Climate, 2019).

In spite of the important contribution of the coast at local, national and global levels, significant natural and anthropogenic changes in coastal systems have been observed and documented throughout the world (Nelson, 2009: Asante et al 2010; Wong et al., 2014; Paice & Chambers, 2016: Ducrotoy, 2020) and these changes are projected to intensify (Hayhoe et al., 2017) with significant impacts on coastal communities. According to the Inter-governmental Panel on Climate Change report (IPCC, 2018), observed changes in natural coastal systems include rise surface temperatures of 1.5ºC, rise in global average sea levels, ocean acidification, intensification of storms and hurricanes, coastal erosion and increased flooding of coastal areas (IPCC, 2018a). According to (Lindsey & Dahlman, 2020), the year 2019 also recorded average global temperature of 1.15ºC which even though lower than what was recorded by the IPCC in 2018, represents a rise in sea level. Coastal modifications lead to changes in aquifers such as salt intrusion, shifts in surface and ground water interaction and fluctuations in discharge and recharge regimes (Anderson, 2017). Given future climate scenarios of temperatures and sea level rise, these changes are expected to intensify and exacerbate impacts on human systems which include dryland loss and submergence. These will affect settlements and livelihoods, damage of built environment by extreme events, effects on freshwater such as salt intrusion, negative effects on energy and health, and loss of cultural heritage, livelihood loss and dislocation of people (Wong et al., 2014)

Globally, the risk of coastal flooding will be exacerbated by sea-level rise and cause significant environmental change. The number of people who would experience flooding by 2080 by storm surge annually will increase by a fifth due to sea-level rise by the 2080s and sea level rise (Neumann et al., 2015b). Sea level rise is likely to cause the loss of about 22% of the world's coastal wetlands (Neumann et al., 2015b). When combined with other losses due to direct human action, up to 70% of the world's coastal wetlands could be lost by 2080. Using foresight scenario assumptions, Neumann et al. (2015b) concluded that the number of people who would be exposed to the risk of coastal flooding in Low Elevation Coast Zone (LECZ) will increase exponentially. Reports collated by the Dartmouth Flood Observatory from 1985 to 2014 shows that globally, floods killed more than 500,000 people, more than 650,000,000 people displaced and over US$500 Billion properties damaged as a result of floods (Kocornik-mina et al, 2015).

In sub-Saharan Africa, submergence of low lying beaches presents a major challenge to most cities, particularly Mozambique, Cameroon, Tanzania, and others (Brown et al., 2011). Using the dynamic interactive vulnerability assessment model on sea-level rise and impacts in Africa from 2000 to 2100, Brown et al (2011) and (2018) observed that while the continent is not the most exposed to sea-level rise, it still poses a significant threat due to its growing coastal population and low adaptive capacity stemming from low national wealth. Their analysis showed that without adaptation, the human physical and financial impacts will be significant with a sea level rise of 43 cm. Approximately 16 million people will be forced to migrate from 2000-2100 with total damage cost of $38 billion per year in 2100. Even with adaptation, the numbers will be significant with

17,000 people experiencing flooding per year, 14,000 people being forced to migrate from 2000-2100, and total damage cost of about $1.1 billion.

The impacts of current and future climate change on natural and socio-economic systems have been well documented (IPCC, 2014). Various studies have been conducted to understand the impacts of flooding economically (Desmet et al., 2018; Anthoff et al., 2010; Neumann et al., 2015), and socially through vulnerability assessments (Kantamaneni et al., 2019 & Nicholls et al., 2008). In the area of migration, flood induce migration has been studied extensively by (Barau, 2013). A systematic review by Fatori & Seekamp (2017) revealed that in the area of climate change and its effects such as flooding and its implications for cultural ecosystem services, cultural resources and cultural heritage there has been little scientifically researched. (Fatori & Seekamp, 2017) reviewed publications before 2003 and found that there was no published article on cultural services, cultural heritage and cultural resource. Between 2003 and 2015, thirty-two publications were identified showing a growing interest in the subject.

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) recognizes that studies in the area of cultural ecosystem services have lagged behind due to the attempt to unpack and value some "cultural ecosystem services" that are not susceptible to biophysical and monetary metrics (Díaz et al., 2018). Cultural Ecosystem Services (CES) are the non-material benefits that people derive from human-ecological relations including tourism, recreation and aesthetic, ingenuity, life teaching, social capital, place attachment, identity, artistic, cultural heritage and agricultural heritage (Gould & Kekuewa, 2017). Cultural Ecosystem Service has become one of the important subjects of investigation due to the recognition of the important role of culture in defining the links between people and nature. The realization of the importance of culture has engendered a paradigm shift in the entire ecosystem service discourse. The review in paradigm from ‘ecosystem service’ to ‘nature contribution to people’ elevates and operationalizes the role of indigenous knowledge in appreciation of the value of nature (Diaz, 2018).

Gould & Kekuewa (2017) have also observed that the field of ecosystems services consistently marginalizes the cultural and social aspects compared to provisioning, regulating and supporting services. This marginalization stems from the attempt to interpret the relationship between people-nature objectively. The neglect of the subjective aspect of people-nature relationship narrowed perspectives from disciplines such as the social sciences. Despite the marginalization, some studies have been carried out by some researchers. For example (Rodrigues et al., 2017) identified the role of open ocean and deep-sea areas in providing cultural ecosystem services and the role of non-natural capital in the co-production of marine and coastal cultural ecosystem services. The new scope of the concept of cultural ecosystem services calls for an urgent need to intensify further research on studies that have already been carried out.

In the industrialized societies, demand for cultural ecosystem services are ahead of other ecosystem services i.e. provisioning, regulatory and supporting services. In traditional communities however CES are important for cultural identity, sense of identity and even survival (Milcu et al., 2013). There are several ways in which coastal flooding can affect CES. Firstly, coastal flooding can permanently affect ‘Place’. Place making is embedded in the physical locale which influence and sets out the boundaries for place attachment. Identities on the other hand are constructed based on occupation and genealogical ties which reflect long traditions. Loss of place and identity represent a significant impact on cultural ecosystem service that also needs to be studied. Secondly, coastal flooding can affect agricultural heritage due to the possibility of saline intrusion, loss of soil fertility and water quality. Last but not the least, coastal flooding can affect landscape beauty, recreation and spirituality.

Sustainable management of ecosystems requires the development of appropriate instruments to support decision-making. This becomes more complicated as environmental systems become more complex with the growing recognition of the linkages between social ecological systems (Matthies et al., 2007). A Decision Support Tool (DST) is an interactive, flexible and adaptable computer-based information system developed for supporting the analysis and solution of complex, poorly structured or unstructured problem. Decision support tools help to identify realistic management choices, integrate information into a coherent framework for analysis and decision-making and provide a transparent framework for all parameters. Finally, uncertainties can be addressed through multiple use of the DST to examine the impact of model parameters and different scenarios on the decision variable (Sullivan, 2005). Decision support tools can be used by policy makers, environmental managers and researchers.

1.2 Problem Statement

Ghana has a coastline spanning 550km and a continental shelf of approximately 20,900 km² (Dadson et al., 2016). It is replete with diverse marine and coastal resources. Some of these resources include fisheries and biodiversity, oil and gas, wetlands and mangroves, lagoons and estuaries, sandy and rocky beaches, sea turtles, manatees, whales, dolphins and birds, historical monuments, ports and harbours (Yaqub, 2017; Mami Wata Project | GRID-Arendal, 2018). The coastal area of Ghana provides significant benefits to coastal communities which include livelihood, recreation and food. The ocean and the coastal zone is an important area for many economic activities such as fishing which accounts for 4% of the gross national product and supports over one million people (Mami Wata Project | GRID-Arendal, 2018).

The coastal zone is experiencing significant changes primarily due to climatic factors and exacerbated by increased human activities, and over exploitation of coastal resources such as beach sediments and vegetation. For example, reduced sediment supply to the littoral zones by the Kokrobite and Densu irrigation schemes have caused imbalanced sediment budgets in parts of Accra coast (Appeaning Addo, 2010). Climatic factors driving the change include wind action, wave energy and sea level rise. Sea level rise enables tides to move more inland during high tides in relatively low lying areas and this trend is likely to continue in many developing countries (Appeaning Addo et al., 2008).

Ghana is considered one of the countries that are highly susceptible to submergence due to the geomorphology, coastal elevation, geology, sea level rise, shoreline change rates, mean tidal range, mean wave height and population density of the coastal areas (Boateng et al, 2017;World Bank, 2017; USAID, 2013). The 3rd National Climate Change Communication to the UNFCCC (EPA, 2015) acknowledges that climate change will have a significant impact on coastal communities and the projections of sea level rise will aggravate erosion rates of between 1.2-2 meters annually (Appeaning et al., 2011; EPA, 2015). Other studies point to the fact that already sea level along Ghana's coast is rising between 2-3mm/y (Evadzi, 2018). Newspaper accounts depict how devastation caused by coastal floods are on the increase and have negatively affected communities along the coast of Ghana (Arthur, 2008; Awumah, 2011; Awudu, 2016).

The most recent compilation of data on disasters in Ghana, including coastal flood disasters, was commissioned by the United Nations Development Programme (UNDP) and executed by the National Disaster Management Organisation (NADMO) in a project titled the *Account of Flood*

Disasters in Ghana (NADMO, 2013). NADMO noted that about 1.3 million people in over 1,800 communities in Ghana have been identified as vulnerable to flooding in general (NADMO, 2013). Within the Eastern coastal zone of Ghana, the prevalence of flooding represents significant threats to many people (Evadzi, 2018). While flooding in this area is generally attributed to rise in sea level, Ly (1980) indicates that the construction of the Akosombo Dam has deprived the beach of adequate sand replenishment resulting in erosion along the shoreline.

A systematic review of literature on the impact of coastal flood between 2010 and 2020 by Mensah & Ahadzie (2020) aimed at understanding the current state of flooding in Ghana revealed that out of thirty-three articles reviewed, the term flooding was used in the narrow sense to mean 'urban flooding' notwithstanding the fact that 'flood' has different types. In addition, their study focused on the causes of urban flooding, the impact in terms of the economic losses and the coping strategies adopted by affected people. A study by Boon (2013) which assessed climate change impacts on ecosystem services and livelihoods in Ghana was another close attempt at understanding the impact of climate variability on ecosystems services around the Sui forest reserve. The study revealed that climate change is a threat to livelihood of communities that depend on the Sui forest. These communities lacked the capacity to adapt to these impacts thereby further impoverishing them. This study however also focused on the broad subject of 'climate change' and 'ecosystem services' although mainly on provisioning ecosystem services.

The Ada coast is one of the areas along the eastern coast of Ghana which experiences coastal flooding. Ecologically, Ada is significant because it hosts the Songhor Ramsar site which approximately 28,740 hectares in size and 20km in length (Birdlife International, 2020). The Ramsar site is s biosphere reserve. In Ada Foah, where the Volta River meets the Atlantic Ocean, coastal ecosystems provide livelihoods, places of dwelling for local people, recreation, religious and tourism. Despite the important benefits that are derived from ecosystems, factors such as erosion, rising sea level and increasing human activities are changing the coastal landscape and are affecting many of these ecosystems thereby reducing their ability to deliver services to people. As ecosystems are affected, the ability of deliver services to coastal inhabitant reduces. An important ecosystem service type which is increasing affected is cultural ecosystems services. Cultural ecosystem services such as place, spiritual, life teaching, aesthetic, recreation etc. become affected due to the fact that they are part of the way of life of the people along the coast. Some changes in coastal landscape include conversion of wetlands to agricultural land or industrial and urban development, degradation of wetlands, population growth, pollution of coastal waters and increased coastal flooding (Ryan & Ntiamoa-Baidu, 2000: Aheto et al., 2011: Yaqub, 2017). In Ada, observed changes include conversion of land use over the last 12 years for expansion of agriculture at the expense of grasslands/shrub (grazing land) (Bosompem et al., 2017), loss of vegetation and reduction in salt production levels (Roland et al., 2019). The need to understand the drivers behind these coastal floods is imperative and more so local perspectives of the drivers of flooding needs to be assessed and understood for comparison and validation. Also important to be understood are the linkages between coastal flooding and CES

1.3 Objective

The main aim of the research is to assess the interlinkages between coastal flooding and associated submergence and cultural ecosystems services in Ada. The specific objectives are to;

- Assess the perceptions of communities on climatic and non-climatic drivers of coastal flooding and submergence in Ada.

- Assess the status of and the linkages between coastal flooding, submergence and cultural ecosystem services.
- Predict the future implications of coastal flooding and submergence on cultural ecosystem services in Ada.

1.4 Research Questions

- What are the climatic and non-climatic drivers of coastal flooding and submergence in Ada?
- What are the cultural ecosystem services in Ada and how has coastal flooding and associated submergence affected the status of these services?
- To what extent can the Bayesian network model be used as a decision support tool to understand the future implications of coastal flooding and submergence for cultural ecosystems services?

1.5 Justification for the Study

Social-environmental sustainability requires that decision-makers and researchers delve into fundamental issues and understand the long-term biophysical sustainability issues of the ecosystem (Sakalasooriya, 2015). The relationship between the human society and the biophysical environment is interconnected and interdependent. To understand the changes in the social system, it is important to also understand the changes in the biophysical environment because changes in one system affects the other. This study is an analysis of the interlinkages between coastal ecosystems and cultural ecosystem services. It is based on the assumption that there is a nexus between coastal flooding which is driven by two principal factors (climatic and non-climatic drivers) and cultural ecosystems services (the non-material benefits that people derive from ecosystems). Climatic factors such as sea level rise and oceanographic drivers (changes in wave dynamics, tidal trends, rainfall et cetera) combine to devastate communities in coastal areas. Sand winning, land use change, urbanisation and increasing population are among non-climatic drivers that contribute to coastal flooding.

The Ada coastal area falls within a biosphere reserve which is protected under the wetland regulation LI 1659 of 1999. The Songhor Ramsar and biosphere reserve serves as habitat and breeding ground for several species including turtles. Other benefits include nutrient recycling in bio-ecological adjustment processes, biodiversity conservation, flood conveyance and water storage, water purification, groundwater recharge, leisure and recreation (Dorm-Adzobu, 2007). Due to frequent coastal flooding in Ada and the increased human activities in this protected area and its impact on cultural ecosystems services it is important to understand and assess the interlinkages in order to ensure that the ecosystem's contribution to people are sustained. Degradation of the ecosystems and the benefits derived from them can have devastating impact on other organisms that depend on the ecosystem for survival. Understanding local perceptions of the drivers of coastal flooding and its linkage with cultural ecosystem services will contribute to understanding what coastal flood related issues exist in Ada as far as cultural ecosystem services is concerned.

The novelty of this study is its focus on culture which is central to human dwelling. Culture (which is the way of life of a group of people), a defining construct which gives people their identity, history, tradition and values is juxtaposed with the biophysical changes that are taking place. The study will contribute to deepening the understanding and the importance of cultural ecosystem service and give attention to cultural ecosystem beyond the label of the Millennium Ecosystem Assessment category (Milcu, 2013). The results of the study will help to understand local perceptions of the drivers of coastal flooding and influence how local knowledge can be adopted for ecosystem management, give insights into aspects of cultural ecosystem services among indigenous people. These insights will help in the mainstreaming of cultural ecosystem services into policy and research as envisioned by the IPBES (Diaz et al., 2018).

1.6 Hypotheses

1. Local perceptions of communities on climatic and non-climatic drivers of coastal flooding and submergence are consistent with established causes of flooding.
2. There are complex interlinkages between coastal flooding and cultural ecosystems which influence the status of cultural ecosystem services.
3. Bayesian Network Modelling of the future of implication of the flooding on cultural ecosystem services presents an opportunity to effectively make decisions regarding the future status of cultural ecosystem services.

1.7 Definition of Key Concepts

Following are definition of the key concepts used in the study;

Flooding

Flooding occurs when water overflows to usually dry land. (Doswell, 2003).

Coastal flooding

Coastal flooding occurs when low-lying land is flooded by seawater (Coastal & Resilience, 2020).

Erosion

Erosion refers to the removal of material from the coast due to wave action, tidal currents or human activities which cause landward retreat of the coastline (British Geological Survey, 2012).

Climatic factor

Any climate-induced factor that directly or indirectly contributes to flooding including sea level rise, storm surge and rainfall (IPCC, 2000).

Anthropogenic

Terrestrially based drivers that emanate from human related activities (Wong, 2014)

Ecosystems

Living organisms of a particular habitat and their surrounding environment functioning together as a single ecological unit (Balasubramanian, 2017).

Ecosystem Services

The benefits people derive from ecosystems (Arico et al., 2005).

Cultural Ecosystem Services

Cultural Ecosystem Services are the non-material benefits that people derive from human-ecological relations i.e. tourism, recreation and aesthetic (Hassan, 2005).

Household

A community unit, whose members live, cook and eat together (Mantey, 2013).

Place

The notion of place can also be viewed as spatial segmentation and is built in the lens of cultural relativity and reflects not only narratives of cultural diversity but also in internationalist celebration of diversity in the "family of nations" (Malkki, 1992)

Cultural Livelihood

Cultural livelihood is the satisfaction people derive from the pursuit of activities that are undertaken routinely and from which fulfilment is derived other than economic or subsistence.

Storm Surge

Storm surge refers to temporary increase, at a particular locality, in the height of the sea due to extreme meteorological conditions: low atmospheric pressure and/or strong winds (Dasgupta et al., 2011).

1.8 Structure of Thesis

The thesis is organised in into six (6) chapters. Chapter one gives the general background to the study within global and continental contexts. This chapter problematizes the issue of coastal flooding and cultural ecosystems services. It defines the general objective of the study as well as the specific objectives and states all the research questions to be answered in the study.

Chapter two reviews literature on global environmental change including coastal environmental change, flooding and its implications for the cultural ecosystem services in general. It examines cultural ecosystems service and the indicators that help to evaluate cultural ecosystems services. This chapter explains the conceptual underpinnings of the study and develops a conceptual framework that links the various concepts used in the study.

Chapter three presents the materials and methods used in the studies. The chapter profiles Ghana and delineates the study area while describing the study communities. It reviews the methods used in the study and presents perspectives on error accounting in shoreline measurements.

Chapter four presents the results of the study based on the objectives as spelt out in chapter one.

Chapter five presents thematic discussions and also illustrates the application of the Bayesian network model as a decision support tool in the management of cultural ecosystem services.

Chapter six, the final chapter, presents conclusions of the research and the recommendations.

CHAPTER TWO

2. Literature Review

2.1 Introduction

Coastal flooding affects many people globally. With climate change projections, the incidence is coastal flooding and subsidence and or inundation is expected to increase. This increase in coastal flooding is expected to affect people, developments and several other ecosystems. From ecosystem perspective, coastal flooding will lead to salinization of coastal aquifers, loss of vegetation, loss of habitats of several organisms etc. More specifically, coastal flooding will affect cultural ecosystems which is defined by its variables or indicators. Understanding the conceptual basis in literature and what gaps remain is important as it will serve as the foundation to filling the gaps identified. This chapter reviews literature on global environmental change, coastal environmental change and ecosystem services. More specifically, it reviews literature on drivers of coastal environmental change, cultural ecosystems services and the indicators of cultural ecosystems services. Finally, a conceptual framework for the study is developed to show the linkages among the various concepts used in the study.

2.2 Discourse on Global Environmental Change

The Earth is a complex system that is interconnected. Aspects of this complex system includes the global economy and society which are interconnected, interdependent and also complex (Brito & Smith, 2012). The system provides opportunity for rapid innovation but is also susceptible to changes such as global financial meltdown and interruptions in global food system. It is this fragility that has engendered current global environmental change.

Global Environment Change (GEC) is referred to as a set of changes to the earth systems, mostly caused by human activities that are likely to have a major effect on human society and ecosystems services (O'Brien & Leichenko, 2008). GEC also involves a set of planetary-scale changes in the Earth System (Dirzo et al., 2014) spanning from largescale changes related to the global geosphere and biosphere systems such as nitrogen and carbon cycles, biodiversity loss, to changes at the local or regional scale and related specifically to human activities which include waste production, extirpation of species and land use changes. It also includes multiple complex changes beyond temperature increase with a global directional shift (Allen & Allen, 2017).

These definitions frame GEC as a universal phenomenon and assume that change is occurring everywhere globally. While there have been extensive changes presented in the definition of the framing of environmental change as a global contest by Pyhälä et al. (2016) in their study *Global environmental change: local perceptions, understandings, and explanations,* they argue that to date most researchers do not include local perceptions and understanding of change. Available research is geographically scattered and generalized. Inherent in their critique is the fact that there have not been enough interactions with people at the local level to attribute such an expansive dimension to the environmental change phenomenon.

Global environmental change occurs systemically by affecting the actual functioning of the earth system like climate change and also cumulatively because they result from localised changes that magnify at the global front including pollution, land use change, soil degradation and plasticisation etc. (O'Brien & Leichenko, 2008). The impact of climate change is predicted by Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2007) to be severe yet unequally distributed across continents, countries and communities. High temperatures are expected in higher latitudes and inland areas and projected to exacerbate melting of ice, softening tundra (Stricherz, 2005) and coral bleaching (Riegl, 2003: Beger et al., 2014) than in tropical regions and coastal areas even though the effects of higher temperatures in higher latitudes is likely to be experienced most in tropical areas due to increased poverty and poor adaptation mechanisms (IPCC, 2014).

Global Environmental change is framed through discourses or paradigms that seek to explain the current environmental challenges and the possible pathways to address them. The first of these discourses as discussed in O'Brien and Leichenko (2008) is the biophysical discourse that frames environmental problems as biophysically based. The biophysical discourse attributes environmental changes to changes in biogeochemical cycles, atmosphere-biosphere-ocean interactions and other natural and physical processes. Biophysical discourse argues that critical to addressing the problem of environmental change is an understanding of how the earth's systems function. Biophysical paradigm is supported by Kilroy (2015) in his review of the biophysical impacts of climate change in three hotspot regions (semi-arid zones, mega-deltas and glacial-fed river basins) in Africa and Asia which concluded that uncertainties associated with the biophysical impacts on these regions under a changing climate although documented represents knowledge gap. This way of understanding the environment could form the basis why environmental problems receive significant attention in international discussions because inherit in the biophysical discourse in the suggestion that drivers of environmental change are transboundary.

Recent catastrophic events such as Hurricane Katrina (Gibbens, 2019) and Landslides in China (Yin, 2011) underscore the linkages between environmental change and social and physical system (International Human Dimensions Programme, 2007). The effects of global environmental change have been the increase in natural disasters which have resulted in deaths and impacted both the rich and poor. Research approaches must therefore aim at integrating both the biophysical and social vulnerability to understand the impact of environmental change (International Human Dimensions Programme, 2007).

The expanding scale, growing magnitude, speeding up and deepening impact of interregional flows and patterns of interaction and the transformation in the scale in human organization that links distant communities and expands the reach of power relations across the world's major regions and continents have also had influences on the environmental change (Held et al., 2003). The accelerations in the use of the internet, the shifts and dynamics in power of sovereign national states, the intricate intertwining of global markets, and the scale of people migrating across regions and continents due to varying reasons such as wars, environmental degradation, or disasters is what has been termed globalization (Boomgaard & Hart, 2010). The forces of globalisation which are trade, culture and technology impact significantly on global environmental health because most of the significant manifestations of change driven by globalisation are happening in cities. Cities in developing countries will account for about 95% of urban growth in the next decade and cities in developing countries will be home to 80% of the world's population (International Human Dimensions Programme, 2007).

Due to the transboundary nature of environmental changes like climate change (Prabhakar et al., 2018) and marine pollution, an international approach to dealing with them is inevitable. This oversight in establishing a relationship between the globalisation discourse and global environmental change using the drivers is replicated in the discussions on other globalisation discourses such as benign globalisation, transformative globalisation and malignant globalisation (O'Brien & Leichenko, 2008).

Critical to the global environmental change discourse is the issue of climate change. Climate Change is one of humanity's nemeses (World Vision International, 2020). Climate change and its effects received significant attention in 1992 at the United Nations Conference on the Environment and Development in Rio. The result was the promulgation of the United Nation's Framework on Convention on Climate Change which came into being in 1994 (UNFCCC, 1997). Global warming and its attendant effects represent a challenge that is detrimental to the populations of the world. Climate change occurs through natural drivers such as ocean's global circulatory system, solar irradiance, volcanic eruptions, internal climate variations and El-Nino – Southern Oscillation (In: Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Research Program et al., 2017) and the emission of carbon dioxide and other greenhouse gases into the atmosphere through human activities (Müller-Kuckelberg, 2012).

The conceptualisation of global environment change can be critiqued from several perspectives. Firstly, the discourse on global environmental change as put forward by O'Brien and Leichenko (2009) appears anthropocentric (the view that only humans have non-instrumental value) in nature. The arguments for actions from both policy and research angle is the interest of man. This is explicit in the call for understanding social vulnerability of the impact of environmental change. The arguments take an instrumentalist view of the environment as opposed to an intrinsic view of environmental health (Hassoun, 2011).

In addition to the anthropocentricism critique, the very notion of change in the expression "global environmental change" raises fundamental difficulties that justify the criticism of anthropocentricism. For instance, the "change" here assumes some disadvantage (total annihilation of the world) for humans now or in the future. The narrative is that if the trend of global environmental change continues, the implication such as drought (Aldous et al., 2011), poor agricultural performance (Müller-Kuckelberg, 2012), erratic rainfall patterns, impact of sea level rise on low elevation coast areas (Neumann et al., 2015a) and threat to human health (Myers,

2009) will make life unbearable. A fundamental question likely to be raised by deep ecologist is why should human beings necessarily have to be at the centre of the change “discourse”? (Rothenberg, 2012). Do we fully understand the impact of these changes and bio-centric effects in terms of bio-centric equilibrium? How are other organisms adapting to the impact of these changes? These are important considerations in the global environmental change discourse.

In spite of the criticisms, global environmental changes are expected to affect people in many ways and across all aspects of human lives including, health, agriculture, habitat etc. For instance in the area of health, Myers, (2009) in a publication *Global Environmental Change*; a threat to human health notes that ecosystem services like clean water, clean air and adequate nutrition that form the pillar of healthcare will be eroded leaving a large number of people vulnerable and susceptible to poor quality of health. In Ghana, the incremental cost of adaptation to climate change in the health sector was estimated at about US$ 350 million by 2020 (Asante et al., 2010). In the area of agriculture, rich soil fertility and predictable rainfall patterns that formed the cornerstone of good agricultural output will be adversely affected in Sub-Saharan Africa as rainfall patterns increasingly become unpredictable and erratic (Müller-Kuckelberg, 2012). The agricultural sector in Ghana will require about US$ 334.24 million in 2020 and US$ 336.30 million in 2050 for adaptation to effects of climate change (Asante et al., 2010). Livestock production is affected by long periods of drought leaving many of the grazing fields with dry fodder (Mastny & Engelman, 2009). In the scheme of the discourse on global environmental change, coastal areas are also projected to experience some changes.

2.3 Coastal Environmental Change

The coastal environment is essentially comprised of the natural and human systems (Arico et al., 2005). Natural systems include rocky coast, beaches, barriers, estuaries and lagoons, deltas, river mouths, wetlands and coral reefs which define seaward and landward boundaries. Human systems on the other hand include communities, transportation, tourism, residential facilities, communication, energy, etc, (Carter et al., 2014).

The importance of the coast is also underscored by the fact that they are places where people live with significant levels of activities including fishing, transportation, tourism, etc. (Celliers, 2015). Coastal systems are also important for economic reasons. In East Africa Seaborne trade volumes increased from 16.4 to 54 million tonnes between 1970 and 2012. Merchant shipping is the backbone of the East African economies. Oil tankers, chemical tankers, gas tankers and general cargo ships ply activities in the Western Indian Ocean. The importance of these services is not limited to the local community but includes national economies, regional trade and global trade. As at 2018, global fish catch was estimated to have reached 179 million tonnes out of which 156 million tonnes was consumed while the remainder was used for non-food purposes such as medicines. Around 60 million people are employed worldwide in fishing, aquaculture and farming (FAO, 2020c). Commercial benefits offered by coastal systems in terms of fisheries and tourism activities also generate significant revenues in these areas. According to the World Bank, oceans contribute about $1.5 trillion annually in valued addition to the world's economy (The World Bank Group, 2020). Fisheries and aquaculture contributed 152 billion in exports out of which 54% came from developing countries (FAO, 2020c). Even though not all of these coastal services especially cultural ecosystem services such as sense of place and identity have been valued to determine their worth (Daniel et al., 2012), various analyses always point to the social cost or benefit that hither to would remain hidden. The importance of Rattan Garden in Indonesia in terms of the spiritual, cultural and local knowledge repository was only known to local people (Afentina et al., 2017). Other benefits of the Coastal system that have been observed include stabilisation of the shoreline, nutrients regulations, carbon sequestration, detoxification of polluted waters and waste disposal (Dayton et al., 2005).

Coastal systems represent one of the important components of ecosystems even as they remain threatened and are undergoing significant changes from both climatic and anthropogenic sources (Dayton et al., 2005). Kang et al., (2015) have observed that land development pressure is the driving force behind coastal environmental change in South Korea. Marine and terrestrial boundaries have been developed intensely over the last past 40 years and this is increasing. In South Africa, declining freshwater supply input to estuaries increasing closed mouth conditions and placing additional pressure on estuarine plants, invertebrate, fishes and birds (Mead et al., 2013). Climate related factors such as sea level rise has caused submergence, flooding, erosion, saltwater intrusion, rising water table and wetland loss (Oppenheimer et al., 2019). In the United State of America (US), the state of Louisiana contains approximately 40% of the country's wetlands and experiences 90% of the coastal wetland loss. It is estimated that about 640,000 hectares of land will be lost by 2050 (Restore or Retreat, 2012). A publication by (Lu & Flavelle, 2019), suggests that by 2050, several cities including Ho Chi Minh City will disappear.

An important part of the coastal system is the human beings who are natural elements of the systems. The high concentration of people in coastal areas has produced economic benefits such as improved transportation and industrial development (Creel, 2003). On the other hand human dependence on these systems has increased significantly in the last century (Dayton et al., 2005) to the extent that the productive capacities of these systems such as fish production are being hampered. For instance, the total maximum catch potential in the world's exclusive economic zones (EEZs) is likely to decrease by 2.8 to 5.3 percent by 2050 (FAO, 2020c). While noting that humans are a natural component of these coastal systems, the trend of population increase creates imbalance in the utilisation of the coastal resources and services (Creel, 2003: Neumann et al., 2015b). Some of these imbalances include reduction in sediment budget caused by urban developments as is the case near the Tedori River in Japan which has been significantly affected by continuous human activities such as dredging activities, sand and gravel mining and multi-purpose constructions (Hai et al., 2013).

Africa's coast, particularly Eastern and Western African coast, is endowed with a wide variety of coastal ecosystems which include estuaries, coral reefs, mangroves, wetlands etc (S Diop & Scheren, 2012) which are important to the economies of countries such as Cape Verde, Sao Tomé and Principe, Mauritius, Somalia and Seychelles. For instance Africa**'s** vast coastline hosts a maritime industry estimated at $1 trillion per year (Vrey, 2017). These ecosystems provide numerous services to many coastal dwellers such as provision of food, recreation and cultural practices (Rodrigues, Conides, Rodriguez, Raicevich, Pita, Kleisner, Pita, Lopes, Roldán, Ramos, et al., 2017). Again, freshwater and ocean fish make a vital contribution to the food and nutritional security of over 200 million Africans (Economic Commission of Africa, 2016). African coast also makes profound contributions to the economic growth of various countries. The North West coast of Africa is one of the richest fishing grounds in the world due to the strong upwelling current in the region (Boisrobert & Virdin, 2008). The West and Central coast of Africa are also rich in mangrove vegetation which serve as sources of livelihood and most of those who depend on these resources in Africa are the rural coastal communities (Bojang et al., 2009). In all, about 10 million people in Africa depend on small scale fishing at both the subsistent and commercial level for their livelihood (Economic Commsiion of Africa, 2016).

In spite of the benefits of the coasts, Africa's growing population in coastal areas driven by high birth rates and migration towards the coast (Neumann et al., 2015a), poorly regulated access to coastal resources and increased availability of fishing technology have led to degradation of coastal environment (Creel, 2003). In local communities, national economies and global economies, coastal systems are experiencing change due to natural processes and human activities (Conti et al., 2017). Some of these changes include salt water intrusion (Li & Chen, 2019), frequent flooding (Nicholls, 2004), reduction in the sizes of deltas due to reduced sediment flows and increased human populations (Day et al., 2019), degradation of estuaries (Kirby, 2019) among others. These changes are expected to exacerbate in the coming years. According to the United States Environmental Protection Agency (USEPA, 2017), climate change will affect coastal environment in a variety of ways because coastal systems are sensitive to sea level rise, increased precipitation, erratic storms and warmer temperatures..

These changes in coastal environment will affect diverse sectors including energy where changes in temperature of coastal waters is expected to affect species that inhabit them. Pollock, halibut, rock sole, and snow crab in Alaska and mangrove trees in Florida are a few species that have begun to shift in the US (USEPA, 2017). In Australia, rising sea temperatures, rising sea levels, ocean acidification and extreme weather events such as flooding are affecting the remarkable Great Barrier Reef as sedimentation smoothers plants (Conti et al., 2017). In Cape Verde which is an island archipelago comprising of a ten small islands and thirteen islets, sea level rise is posing risk of submergences to these islands while in the Gambia, it is projected that about 92 km^2 of land in the coastal zone will be inundated as a result of a 1meter sea-level rise (Manno et al., 2017). It is important that drivers of these changes in coastal areas, especially in Africa, are understood to inform policy choices and mitigate future impacts.

2.3.1 **Drivers of Coastal Environmental Change**

The coastal system is in constant flux driven by both natural processes and human induced processes (Azuz-Adeath & Yanez-Arancibia, 2019). Understanding the natural and human processes that account for these changes from theoretical standpoint is important in appreciating the dynamics of the changes within the coastal environment. Day & Rybczyk (2019) have revealed that climate change will impact coastal system but even more profoundly, climate change will interact with other global forcing to threaten both natural and human systems within the coastal zone. This view of the implication of climate change for the coastal systems presents a complex connection between climate change and coastal systems on one hand and between coastal systems and human systems on the other hand. A plausible third scenario will be between climate change and human systems.

While coastal environmental change is often attributed to climatic and human related causes, Helderop & Grubesic (2019) categorise the drivers into three by adding geomorphic factors such as subsidence and shoreline erosion. Oceanographic drivers of flooding such as wave, wind and tide are also classified as climatic drivers of coastal change (Wong et al., 2014). The combination of these classifications produces four categories. These are geomorphic, oceanographic, climatic and anthropogenic. This classification presents a clearer classification for more detail interrogation of the theoretical framework.

Among the drivers of change in coastal areas, Sea level rise is projected by IPCC (2014) to cause serious impact on coastal systems. Relative sea level rise has been largely attributed to global warming which is the increase in surface and sea temperature (IPCC, 2018b). Other climatic factors that are driving coastal changes include severe storms such as tropical storms which cause storm surge in coastal waters (Min et al., 2011; Stone et al., 2011). Sea level rise is resulting in wetland accretion of inorganic and organic sediments at a rate equal to or greater than the rate of SLR. Estuarine habitat is migrating upslope as sea level rises and wetlands have seen an increase in frequent inundation that leads to a shift in the distribution of vegetated habitats (Day & Rybczyk, 2019).

Human activities including the expansion of transportation infrastructure such as roads networks, development of new harbours and landing beach sites have also contributed to changes in coastal systems. The changes include loss of habitats, productivity and biodiversity, degraded water quality and changes in natural coastal and marine environment equilibrium (Diop et al., 2014). These drivers are expected to continue to affect coastal systems with increase in population as is the case with the Chesapeake Bay Watershed where human activities are causing nutrient enrichment from treatment plants which have had noticeable effects on human health (Elia et al., 2020). Fresh water flows to coastal areas can have implications for the coastal system. Increase in freshwater enhance soil accretion and also fish production. On the other hand, freshwater from surface run-off can increase eutrophication. Changes in the balance of freshwater flows to the coast through urbanisation and increase in population also affects the coastal system (Elia et al., 2020). Pollution levels are expected to exacerbate whiles the rate of eutrophication and the prevalence of hypoxic increase (Wong et al., 2014).

2.4 Coastal Flooding

Flood has been defined as an intersection between dynamic hydro- meteorological variability and geographically fixed geomorphological features (Rajendran et al., 2017). The Office of Disaster Preparedness and Management (ODPM) of Trinidad and Tobago also defines flood as the accumulation or an overflow of an expanse of water that covers or inundates land that is usually dry (ODPM, 2013). The World Health Organization (WHO, 2020) has observed that floods are normally caused by heavy rainfall, rapid snowmelt or a storm surge from cyclone, hurricanes or tsunami in coastal areas and between 80-90% of documented disasters from natural hazards during the past 10 years have resulted from floods, droughts, tropical cyclones and severe storms. This is corroborated by Prakash et al. (2020) who have observed that flood is often associated with heavy rainfall and can also occur in other ways that are not associated with weather such as dam spillage (Amuquandoh, 2016). To fully understand what flood is, there must be separation of the understanding from meteorological processes notwithstanding the atmospheric processes that influence its occurrence (Bryndal et al., 2017). Climate-related changes in the intensity and frequency of atmospheric moisture movement, and their intersection with river basin dynamics can also be responsible for significant variations in the frequency, severity and distribution of floods (Rajendran et al., 2017). Climate undergoes natural fluctuations through persistent and oscillatory regimes at intra-seasonal, inter-annual, as well as decadal and as a function of anthropogenic changes of the atmosphere and land surface (Chavez et al., 2016). Flood also occurs when water overflows to usually dry land.

A review of the International Disaster Database shows that rain flood is the most common type of flooding on a global scale and accounts for the largest impact on human systems (The Centre for Research on the Epidemiology of Disasters, 2020: Crunch, 2020). Between 1998-2017, floods affected more than 2 billion people worldwide and most of these people lived in flood plains and lacked access to early warning systems (WHO, 2020). Other sources of flood are geomorphic in nature and anthropogenic (Kalijaga, 1998).

Different types of floods have been identified by different researchers from different geographical origins. Doswell (2003) and Hendry et al., (2019) classify floods into flash floods, river floods and coastal floods. (Hundecha et al., 2017) have identified riverine flooding, Urban drainage, Ground failures, fluctuating lake levels, coastal flooding and erosion as the various type with several sub-types. Applying cluster analysis technique to hydrological and hydrometeorological variables Hundecha et al. (2017) identified four types of flooding in Europe. These are short-rain floods, long-rain floods, snowmelt floods, and rain-on snow floods. Short-rain floods are characterized by intense down poor of rain over few hours while long-rain floods occur for several days. Snowmelt floods occur when temperatures rise above freezing levels in a catchment area of snow. Rain-on snow floods is characterized by rainfall on ice which exacerbates the melting of ice. Maddox (2014) identifies 3 main types of flooding which are coastal flooding, fluvial and pluvial flooding and these classifications are based on the causes of the flood event.

While these classifications based on clustering of flood event types can be useful for flood characterisation, Turkington et al. (2016) have noted that due to climate change, the patterns and drivers of flooding will change significantly in the coming years. This will require developing new models for flood classification. Coupling a multi-site weather generator to HBV rainfall-runoff model (Seibert, 2005) which extracted 1200 years of simulated data and defined flood as days with discharge that can lead to flood. They classify floods based on their meteorological triggering conditions and flood timing. Their study revealed that flood typologies are likely to change in future due to climate change. For example, long-rain floods will change to short-rainfall and periods of occurrence is likely to be more frequent. Their study was limited in scope and the variables used; Ubaye catchment (548 km2) in the southern French Alps and the Salzach catchment (4637 km2) in Austria. The main variables were precipitation and temperature.

Coastal flooding is likely to occur due to functional and structural failures of natural barriers or coastal defences under three scenarios which are firstly the water level exceeds the crest elevation of natural barriers or coastal defences; secondly waves rush up the shore and over top the crest of natural barriers or coastal defences; and thirdly natural barriers or coastal defences are breached or undermined (Sallenger, 2000). Coastal flooding occurs on the coast of a sea, ocean or location that is close by a large body of water. This is usually the result of extreme weather conditions. Coastal flooding has three main categories which are characterised by the extent of their impact (Maddox, 2014).

The first type, referred to as Minor coastal floods, normally causes slight beach erosion with no significant damage to property. Moderate coastal floods cause some amount of beach erosion with fair amount of damage to homes and properties. Major coastal floods cause significant amount of beach erosion and affects significant properties and disrupts livelihoods (Maddox, 2014). The second type of flood, referred to as fluvial floods or riverine floods also occurs when excessive rainfall over a long period causes a river to exceed its capacity. This type of flood normally affects small rivers and dams by causing them to break up. According to Maddox (2014) Riverine floods are of two main types. There are the overbanks flooding which occurs where the river overflows its edges. This can occur irrespective of the size of the river. The second type of fluvial flood is the flash floods which are often dangerous and destructive because it is characterised by force and carries lots of debris with it. The main determinant of the severity of riverine flood is rainfall. Projections of river floods are usually based on models that take into account, past floods and future forecast and variations in temperature (Maddox, 2014). The third type of flood, the Pluvial Floods, is caused by heavy rainfall that creates a flood event independent of any water body. This type of flood can occur in any urban setting and are of two types. This is also determined by the characteristics. The first is associated with intense rains that saturates the urban drainage systems and overflows onto the streets into homes and other facilities. The second is from run-off water resulting from the inability of the land to absorb excess water due to the nature or type of soil (Maddox, 2014).

The effects of floods can include health consequences arising from contamination from micro-organism, shortage of potable water and breakdown of healthcare system. Flooding also causes livelihood disruption, damage to property and has long term implications for victims such as migration (Doswell, 2003). The total cost of coastal flood damage in Côte d'Ivoire is estimated at US$1.2 billion per year (World Bank, 2019). Due to the devastating nature of coastal flooding, it is important to understanding the drivers that are causing these pressures.

2.4.1 **Drivers of Coastal Flooding**

Flooding in coastal regions occur from four primary source which are; storm surge combined with high astronomical tide (storm-tides); (2) local or remotely (swell) generated waves; (3) river discharge (fluvial); or (4) direct surface runoff (pluvial) (Hendry et al., 2019). The first two sources are of oceanographic source and character, and the remaining two mainly arise from heavy rainfall, dam spillage and other anthropogenic sources. A review of literature shows that flood risk assessments consider these four main drivers of flooding separately (Tanaka et al., 2017: Hsu et al., 2017: Coquet et al., 2019)

According to Hendry et al. (2019) in coastal regions floods are often caused by a combination of factors interacting together in ways that can be devastating to communities. In situation when two or more drivers combine to inflict flooding, it is referred to as "compound flood event" (Hendry et al., 2019).

Bevacqua et al. (2018) have defined compound flooding as an extreme event taking places in low-lying coastal areas and high sea level and large amounts of runoff caused by precipitation. Most of the references to compound flooding assume that interacting factors are oceanographic in nature (Andrews, 2012, Bevacqua et al., 2018, Hendry et al., 2019). The fundamental basis to challenge this assertion is that in most developing countries, the drivers of flooding are not only oceanographic or climatic. Most often, the drivers of flooding are a combination of anthropogenic, oceanographic and climatic and so can be referred to as compound floods. This study focuses on the interactions between these three broad drivers as the main drivers of flooding.

The review of the drivers of flooding in this study considers oceanographic, climatic and anthropogenic causes of flooding. Oceanographic and climatic drivers are reviewed under one heading and anthropogenic factors are reviewed under a separate heading.

It is important to understand that when discussing flooding and the sources or causes, distinction should be made between proximate causes and underlying causes. Proximate causes are the human activities or immediate actions at the local level such as sand mining that originate from intended land use and directly impact or induce flood (Geist & Lambin, 2002). Proximate causal factors answer the question "How?" (How do the factors cause flooding?). This factor is causal at the immediate, direct level (Muir, 2000). It explains the mechanism adopted to achieve a particular outcome or that leads to a particular outcome (Cox, 2011). Underlying drivers on the other hand are the fundamental social processes, such as human population dynamics or land tenure system, institutional coordination that underpin the proximate causes and are indirectly impacted by policies at the national or global level (Geist & Lambin, 2002).

2.4.2 **Climatic Drivers of Coastal Flooding**

Climatic and oceanographic factors considered for review in this study include, sea level rise, wave and wind climate, erosion and rainfall based on Hendry et al. (2019) and Kalijaga (1998). The following sections elucidate the individual drivers of flooding and how they affect flooding and their impact.

2.4.2.1 Sea-Level Rise

The most significant impact on coastal systems is expected to be caused by climate induced sea-level rise which is likely to inundate coastal areas and remove natural buffers (Church et al., 2001). Sea level rise is expected to be caused by two main factors; thermal expansion of ocean waters and the melting of ice sheets around the world (IPCC, 2018). The IPCC (2018) is unequivocal about the onslaught of climate change and notes that human activities have caused an estimated increase of between 0.8ºC and 1.2ºC global warming above pre-industrial levels. This is estimated to increase to 1.5ºC by between 2030 and 2052 in a do-nothing scenario. The consequence of this warming is general changes in global climate and more specifically, changes in global temperatures and also significant increase in sea level rise (Shahzad, 2017). It is almost certain that sea level will continue to rise even after 2100 however, the margins of increase will vary depending on the adjustments that are made to CO^2 emissions (Church et al., 2013). A slower rate of increase will enable human and ecological systems in low lying areas, island communities and deltas to develop adaptation measures to cope with these changes (Oppenheimer et al., 2019). Increased warming of global temperatures therefore means higher exposures of small islands and low-lying coastal areas from sea level rise induced flooding. Other implications of sea level rise on human and ecological systems include increase salt intrusion and loss of ecosystems services. A reduction in global temperatures will only mean a slower rate of manifestation of the effects of the impacts.

Crist (2007) has criticised the concentration of both researchers and policy makers on greenhouse induced climate change to the neglect of the more fundamental ecologically destructive issues of patterns of production, trade, extraction of natural resources, land use, waste proliferation, high consumption and high population growth. While admitting the reality of global warming and climate change, she argues that framing climate change as the biggest catastrophe to civilisation and ushering it to the centre stage of research and policy is the driving force behind the proliferation of technical proposals to dealing with specific challenges such as reviving nuclear power, increasing efficiency of fossil fuel use and developing carbon sequestering technologies. From policy perspective, it the driving force behind "treaty-by-treaty" approach to tackling of the problem of global warming. Crist (2007) further argues that instead of confronting the forms of social organisations that drive climate crisis and other catastrophes, the climate change discourse continually focuses on the impacts of global warming and not the perpetrators of the warming. There are equally important older catastrophes such as mass extinction of species, devastation of the ocean by industrial fishing, old growth deforestation, top soil loss, desertification, endocrine disruption, incessant development. All these are made to appear secondary. In addition, she argues that there are extensive biodiversity losses which can be likened to the holocaust and which have been in the domain of scientist and policymakers but do not receive the needed attention by the mass media. Indeed bio-depletion as a global problem is not mentioned to predate climate change. Finally, Crist (2007) argues that climate change is not the problem but the unbridled civilisation which is the consequence of greenhouse concentration. Civilisation will continue to weaken the intrinsic resilience of life in the phase of environmental challenges.

Houston & Dean (2011) in their study have also showed that while there is evidence of sea-level rise, acceleration of sea-level only occurred in 1930. Between 1930 and 2010, there was no acceleration in sea-levels. Analyzing monthly-averaged records for 57 U.S. tide gauges in the Permanent Service for Mean Sea Level (PSMSL) database that have lengths of 60–156 years they conclude that there is no indication of acceleration in sea level in U.S. tide gauge records during the 20th century. What they observed was rather some deceleration during the period.

Fundamentally both Crist (2007) and Houston et al. (2011) agree that there has been a rise in global temperatures. Houston et al. (2011) also agree that here has been increases in sea levels however projected acceleration sea level rise is not evident is their study. Based on the admissions of these researchers and evidence of the impact of sea-level rise (Appeaning et al., 2011: Brown et al., 2018: Kantamaneni et al., 2019) it is important to understand the implication of current trends of sea level rise on ecosystems in general and cultural ecosystems in particular due to the important role cultural ecosystems service play the lives of people such as provision of sense of place and identity.

2.4.2.2 Wave and Wind Climate

Changes in wind affect wave climate and also affects longshore current systems and therefore upwelling systems (Narayan et al., 2010). The amount of energy that is released via wave breaking also contributes to longshore and cross-shore current, elevated coastal sea levels through wave set up, run-up and beach erosion. Wind and wave play a significant role in the shoreline process and presents a threat to coastal inhabitants (Seneviratne et al., 2012). The impact of coastal wave climate is correlated with wave direction, period and coastline which influence shoaling and refraction (Wong et al., 2014). Long periods of swell which dominates wave energy field present a significant danger to coastal structures and can cause significant flooding of coastal areas. Confidence in the trends calculated from measurements of mean and extreme winds has been low due to the limited length of recording and uncertainties associated with different wind measurements and differences in techniques (Wong et al., 2014).

Wind climate or patterns are likely to change significantly due to climate change. In terms of the intensification or the weakening of various wind systems studies carried out by Gallagher et al (2016) and Dary et al (2018) have shown decreases in wind speed in the equatorial ocean region and Europe respectively. On the other hand, Sydeman & Rykaczewski (2014) through observation from reanalysis models have identified intensification in parts of Benguela and California systems. Variations in wind climate have significant implication for wave dynamics that are generated from these systems and therefore the extent of erosion experienced in affected areas.

More intensive waves are causing severe coastal erosion and coastal flooding with projections to increase with an increase in global mean sea level rise (Wong et al., 2014). Fernandino et al (2018) have observed that wave climate is one of the important drivers of coastal environmental change albeit, it has not been well researched to understand the geophysical and societal effects. This being the case, it is important to understand the extent to which wave and wind climate is influencing change at the local level.

2.4.2.3 Runoff

Among the drivers of coastal flooding, runoff from rainfall is arguably one of the principal drivers of flood. Runoff is defined as that part of precipitation, snowmelt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers (USGS, 2017). Dubeux & Sollenberger (2020) have also defined runoff as water discharged into surface water bodies which normally occurs when rainfall is more than soil infiltration rate. Runoffs are mostly characterised according to the speed of the appearance after rainfall or melting of snow as direct runoff or base runoff and according to the sources of the surface runoff, storm interflow, or groundwater runoff (USGS, 2017).

There are physical characteristics and meteorological factors that affect runoff. Some of the meteorological factors that affect runoff include the type of precipitation (rain, snow, etc), rainfall intensity, rainfall amount, rainfall duration, distribution of rainfall over the watershed, direction of storm movement and other meteorological and climatic condition that affect evapotranspiration such as wind, temperature and relative humidity. The physical characteristics include, vegetation, soil type, land use, drainage area, basin type, elevation, topography, drainage network patterns and ponds, lakes, reservoirs, sinks etc in the basin which prevents or alter runoff from continuing downstream (USGS, 2017). Dubeux & Sollenberger (2020) have also observed that factors affecting runoff include rainfall intensity, slope, soil water storage capacity, and infiltration rate. These perspectives show that there are several factors that determine the extent to which surface runoff can cause flooding in coastal areas.

Runoff is a major cause of flooding in coastal areas and is known to cause both fluvial and pluvial flooding (Rezaie & Ferreira, 2019). In Bangladesh excessive rainfall-runoff during the monsoon season causes fluvial flooding in coastal areas due to the fact that large volume of upstream flow exceeds the conveyance capacity of the rivers. Bevacqua et al. (2019) have documented incidence of compound flooding in many parts of Europe that resulted from the interaction of high sea levels and increased precipitation. Some of these incidents include flooding of the water board Noorderzijlvest, which led to precautionary evacuation in the Netherlands in 2012 and the Avon flood in Bristol in 2014. Other impacts of runoff include nutrient enrichment of coastal deltas and estuaries (Elia et al., 2020). An example is the Chesapeake Bay where nutrient enrichment has led to the loss of submerged aquatic vegetation (SAV) and the concentration of toxic substances such as pesticides and herbicides and affected water quality (Elia et al., 2020).

2.4.2.4 Erosion

Coastal erosion is a worldwide marine hazard (Yincan et al., 2017). Erosion refers to the removal of material from the coast due to wave action, tidal currents or human activities which cause landward retreat of the coastline. The effect of erosion can be observed from cliffs and beaches and the most impacted are those living in coastal lowland areas where coastal erosion can cause flooding and loss of land (British Geological Survey, 2012). Coastal erosion is usually the result of human activities and natural environmental changes which makes the coastal dynamic action (wind, wave and current) lose balance in the coastal process and loss of sediments in the coastal zone causing coastline retreat and beach erosion (Yincan et al., 2017). The natural environmental changes include the effect of river diversion, global sea level rise and aggravation of storm surge. Human causes include sand mining, reduced sediment flow to deltas and estuaries due to construction of dams, artificial sand mining and negative effects of coastal engineering (Yincan et al., 2017).

Coastal lands are being swallowed by seawater and coastal communities and houses are forced to move inland and, in some cases, relocate, which squeezes the living space of humans, destroys biodiversity and ecological balance, and impacts human life and natural environment (Yincan et al., 2017). In Senegal, coastal erosion is shrinking the coastline at an estimated annual average of between 0.5m and 2m per year (Ndour et al., 2018).

The west African coast has recorded significant levels of coastal erosion even though it host to vital natural resources as well as habitats that provide critical ecosystems services (Alves et al., 2020). The west African coast hosts about a third of the total population and contributes about 56% to Gross Domestic Product (GDP) (World Bank, 2019). In spite of the important contribution of the coast, flooding and erosion are the major forms of degradation along the West African coast.

2.4.3 **Anthropogenic Drivers of Coastal Flooding**

Anthropogenic drivers of flooding refer to a wide range of terrestrially based human-related factors that interact with climate related drivers to exacerbate the effects of flooding (Wong 2014). Together with the climatic drivers they confound and compound flooding in coastal communities. Some of these drivers include urbanisation, socio-economic development, hypoxia, sediment delivery, encroaching developments like harbours, industrial activities, sand mining among others.

2.4.3.1 Urbanisation

About 10% of the world's population representing some 600 million people live within low elevation coastal zone which constitutes about 2% of the world's total land area. In spite of this imbalance in the proportion of people to land in coastal areas, there continues to be an increase in the number of the people who settle in coastal areas. Added to this trend is the growth in demand for highly valued coastal lands for expensive developments across the world. These high pressures on coastal lands are leading to the destruction of wetlands and dunes which serve as buffer that reduces wave intensity (Wong et al., 2014).

Urban developments have also caused the number of the people living in coastal area to increase and with it are the increases in other drivers such as increase in dissolved inorganic nutrient load. The construction of hydro-dams to generate electricity to fuel developments have also led to reduced sediments delivery flow to nourish beaches along coastal areas and reduce flooding. Aquaculture intensification which is driven by the need to produce more fish to feed coastal population also affects the coastal landscape and changes the hydrological cycle, blocks creeks and weakens the geology most of which are sandy (Wong et al., 2014).

Another driver of urbanisation is population increase. There are two ways in which population affects urbanisation. Firstly, population increase resulting from high birth rate influences demand for residential, commercial and infrastructural facilities. Secondly, the diversified resources in coastal areas, leads to a high rate of movement of people from other areas to coastal areas in search for better living conditions. This increases the number of people who live along the coast and drives demand for amenities such as schools, hospitals, etc.

High population growth and high rate of urbanisation contribute significantly to coastal land use change as they are associated with destruction of coastal wetlands that serve as buffers that reduce wave and storm impacts. Urbanisation also increase pressures on coastal systems by exacerbating sediment delivery which in turn leads to siltation. High population in Bangladesh and China have led to land reclamation which have also contributed to significant coastal floods (Wong, 2014).

2.4.3.2 Sand Mining

Sand mining or sand extraction refers to a type of open-cast mining that provides material for construction (J. V. Mensah, 1997). Sand is mined globally and together with gravel, account for the largest volume of material extracted and the highest volume of raw material that is used on the earth's surface apart from water (UNEP, 2014b). Sand is one of the aggregates in the construction industry (road embankments, shoreline developments and land reclamation) and has always been an important material globally. In Morocco, sand smugglers have transformed a large beach into a rocky landscape (UNEP, 2014a).

Notwithstanding the importance of sand, the rate of extraction has become a matter of concern to policy makers due to the negative impact it has on the environment (UNEP, 2014a). More alarming is the fact that data on the rate of sand extraction globally is not available and this has affected the level of awareness in terms of the magnitude of the negative impacts. It is important to indicate the preference of marine sand for construction and reclamation due to it binding ability. Unlike the marine sand, the desert sand lacks the ability to bind well with other aggregates. Due to its suitability for construction coupled with high economic growth and population increase, demand for sand has grown exponentially (UNEP, 2014b).

The most significant impacts of sand mining are on rivers, deltas, coastal and marine ecosystems, loss of land through river and coastal erosion, lowering the water table and reducing sediment supply to the coast. Sand mining also reduces protection against extreme events thereby exposing people to risks. Sand mining affects biodiversity, water turbidity and landscape beauty. In extreme case, sand mining has changed international boundaries by wiping out sand islands in Indonesia. Sand mining has also led to deepening and widening of the Lake Poyang channel which is the largest freshwater lake in China (UNEP, 2014b).

Measures to reduce sand mining have become imperative in order to reverse the rate of the devastating effect of the menace. Some of the required measures include the optimisation of existing building and recycling of building material especially sand. Introduction of tax regimes and provision of incentives to encourage the use of alternative materials (UNEP, 2014b). Research should also be intensified in the area of material science to introduce new technologies into the building industry.

2.5 Ecosystem Definition

The term ecosystem first appeared in the publication of the British Ecologist Arthur Tansley in 1935 (Trudgill, 2015). Ecosystem is composed of two word ‘eco’ which means a part of the world and system which refers to the coordinating units (Balasubramanian, 2017). Living organisms of a particular habitat and their surrounding environment functioning together as a single ecological unit is referred to an ecosystem. It is a naturally occurring assemblage of life and environment. Ecosystems are of different sizes. It can be as small as a pond and as large as the ocean. The term ecosystem has often been conceptualised simplistically as a community of species ignoring the broader relationship and interaction that occurs among communities of species (Balasubramanian, 2017). Ecosystems have physical environment or factors and biological components which interact together. They are characterised by biotic and abiotic components which function together.

The dimension and spread of an ecosystem may vary and depending on the existence and dimension it can be classified as macro-ecosystem or micro-ecosystem (Balasubramanian, 2017). Larger ecosystems like forests that spread in terms of dimension can be classified as macro-ecosystems whereas ecosystems with smaller dimension like a pond can be classified as micro-ecosystem. The functions of an ecosystem include the flow of energy through the medium of living organisms going about their activities, serving as food chains, circulation and transformation of elements and nutrient, ensuring biodiversity and biomass and development and evolution and control. Because ecosystem is a balanced system that functions at equilibrium, an alteration of the system can lead to some imbalances (Balasubramanian, 2017). For example, the destruction of a forest can lead to the following; destruction of habitat of some animals, increase the amount of light that reaches the forest floor, reduce the amount of food for organism that depend on those trees for food and reduce the amount of carbon dioxide taken from the air and also reduce the oxygen supply in the atmosphere.

In the context of this review however, the study adopted the definition of the Millennium Ecosystem Assessment Synthesis Report (2005) which defines ecosystems as ‘a dynamic complex of plant, animal and micro-organism communities and the non-lining environment interacting as functional unit”. Understanding the scope of the definition of ecosystem helps to appreciate the wide variety of living and non-living things within the environment that are potential sources of ecosystem services in general and cultural ecosystems in particular.

2.6 From 'Service' to 'Contribution': a paradigm shift of the ecosystems discourse

Ecosystem Service has been defined as the benefits that are provided by the ecosystems (Arico et al., 2005). However, it is important to understand the meaning of the term "ecosystem" Ecosystem is used in varied ways by researchers in different disciplines and policy makers in different fields or sectors of society. In its general sense, it often refers to a complex system with several interconnections. In the context of this review however, I have adopted the definition of the (Arico et al., 2005) which defines ecosystem as "a dynamic complex of plant, animal, and micro-organism communities and the non-living environment interacting as a functional unit" (Arico et al., 2005). The appropriateness of this definition is due to the relevance of the recognition of all aspects of the environment that is biotic and abiotic communities.

The world's ecosystem has been significantly altered mainly from human actions which have occurred more rapidly in the second half of the 20th century have been affected virtually all ecosystems (MEA, 2005). Some of the most affected ecosystems include freshwater systems which have been modified through the creation of dams and alterations of the structures of water flow. This impact is exacerbated by the rising demand for water for domestic and industrial uses. Human activities such as large-scale farming and industrialisation directly and indirectly impact the nitrogen and phosphorus cycles of fresh waters systems and marine systems. Coastal systems and forests or woodlands have also been transformed by 11% and 42% respectively. While most of these changes or conversions started as far back as the 1700s, the rates of change have been more rapid from the 1950s (MEA 2005).

Changes in the status of ecosystems affect the capacity to deliver services to people who depend of them for their survival. With about 60% degradation (MEA, 2005), the capacity of ecosystems to provide services is likely to be affected even though the complete understanding of the nature of the impact is yet to be studied. In the area of provisioning, it has been recorded that fish capture has reduced significantly. The FAO (2020c) has also observed that the fraction of fish stocks within biologically sustainable levels have decreased from 90 percent in 1974 to 65.8 percent in 2017 and thus is unlikely to meet SDG Target 14.4 which is to end overfishing of marine fisheries by 2020. Other factors such as overfishing (fishing mortality or the rate of fish killed by catching them) and ocean acidification (increasing levels of dissolved oxygen in seawater arising from increased carbonic acid concentrations (Isensee & Valdes, 2015)) and microplastic contamination of the ocean (Avio et al., 2016) which continue to plague marine ecosystems. Climate regulatory function of the ecosystem has been affected by the climate change (Geest et al., 2019). This change in regulatory function is driven by greenhouse concentration in the atmosphere exacerbated by land use change such as cultivated maize fields, rice paddy fields, cattle kraals etc which also increases the amount of carbon dioxide and other greenhouse gases such as nitrate oxide and methane in the atmosphere (Maccarthy et al., 2018). In terms of the cultural services, ecosystems changes affect the cultural identity and social resilience of people because the cultural heritage and social interactions are shaped by ecosystems (Vasiljevic & Gavrilovic, 2019). It has been observed that while the demand for cultural services has been in the increase, the ability of ecosystems to render these services is being diminished.

Even though there is a general consensus that there is a relation between ecosystem health and human well-being (WHO, 2005: Corvalan & Hales, 2005: Wang et al., 2017), the complete understanding of this relationship is yet to be understood. Drought, freshwater shortage and hunger in many parts of the world have caused severe stress to people. On the flip side, fresh water availability and availability of food bring relief to people. Simplistic as it may appear, it is evident that the services of ecosystem when ecosystem functions well bring relief to people and therefore promotes well-being.

Notwithstanding the crucial roles of ecosystems, the conceptualisation of 'ecosystems services' as articulated in the Millennium Ecosystems Assessment Report raises fundamental issues in the field of environmental ethics. At the theoretical level the concept reinforces the man-nature dichotomy, a constructs of nature and humanity as separate categories (Tulloch, 2015). It takes an instrumental view of ecosystem rather than intrinsic. The concept of intrinsic value of nature places an inherent value within the ecosystem. From the intrinsic perspective, man is part of nature and therefore must take an egalitarian approach to utilisation of ecosystem resources (Benshirim, 2016). It emphasises on biocentrism (the view that all living things are morally considerable) (Attfield, 2016) and advocates biocentric egalitarianism as the aspiration of all environmental action.

The concept of "ecosystem service" is also at odds with the tenets of deep ecology and it what deep ecologist will refer to as shallow ecology (Benshirim, 2016). Deep ecology "refers to an environmentalism that believes that fundamental changes in our conceptual relationship with nature are a necessary way out of the ecological crisis" (Rothenberg, 2012). It is an environmental principle that places intrinsic value on both abiotic and biotic aspects of the environment. It proposes a radical way of reorganising our environment to conform to the intrinsic philosophy. Some of the tenets of deep ecology are that humans have no right to reduce the richness and diversity of the environment except to satisfy vital needs; that non-human life has intrinsic value independent of the usefulness to man and that human interference in the environment presently is excessive (Rothenberg, 2012).

The conceptualisation of ecosystem service is also criticised for being dominated by the economists and natural scientist. Natural scientist and ecologist defined "ecological production functions" to determine the supply of services and conceptualized as flows stemming from ecosystems (stocks of natural capital) (Díaz et al., 2018). Economists on the other hand use estimates of monetary value of ecosystem service flows to identify trade-offs among them and impacts on well-being. This nature-human relationship conceptualisation failed to include the social and humanistic dimension including local experts and local knowledge. This narrowed view of the concept excluded disciplines, stakeholders and worldviews. For example, cultural ecosystems services which are not amenable to monetary valuation have lagged behind in research while stakeholders like local experts have been relegated to the fringes (Díaz et al., 2018). This criticism of the MEA-led conceptualisation of ecosystem services culminated in the reconceptualization of ecosystem service to include knowledge systems, worldviews, interests and values. This paradigm shift views ecosystem services as Nature Contribution to People (NCP). NCP is defined as all the contributions, both positive and occasionally negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life (Pascual et al., 2017; Díaz et al., 2018). Positive contributions include the provision of ecosystems and negative contributions include diseases transmission, disaster and predation. Nature also refers to biodiversity and ecosystems and other analogous concepts such as natural capital (UNU-IHDP & UNEP, 2014). The new paradigm was evolved by the Inter-governmental Science-Policy Platform for Biodiversity and Ecosystem Services (IPBES) a global effort by governments, academia, and civil society to assess and promote knowledge of Earth's biodiversity and ecosystems and their contribution to human societies in order to inform policy formulation (Díaz et al., 2018).

The previous perspective from the science and economics viewed the flows of relationship as coming from nature to people, a distinction which is sharp. According to Diaz et al. (2018) NCP identifies 3 main categories of contributions which are material, non-material and regulatory and there are 18 sub-categories. The classifications are based on the contributions they make to quality of life. Material contributions are subsistence, objects and other elements from nature that directly sustains peoples' physical existence. They include food, energy and other extractive natural resources. Non-material contributions are nature's effect on subjective or psychological aspects underpinning people's quality of life at the individual and community level. Example includes ocean, forest and mountains and the opportunities they create for recreation, life teaching, inspiration and social cohesion. Regulatory contributions are the functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people or regulate the generation of material and non-material contributions (Díaz et al., 2018).

Notable among these categories is the permeation of culture rather than limiting culture to cultural ecosystem service category in the MA framework. Apart from the 3 categories, there are 18 sub-categories of contributions. The sub- categories are not mutually exclusive as they overlap. For instance, food is a material contribution to people but it is also a symbol of identity. In this sense, non-material and material contributions are interlinked.

The shift in paradigm aims at providing space for context-specific perspectives that provide multiple ways of understanding and categorising relationship between people and nature. It is also to facilitate a respectful cooperation across knowledge system in the co-construction of knowledge for sustainability. This new paradigm is still evolving, and it is at an infant stage.

2.6.1 Type of Ecosystem Services

According to the Millennium Ecosystem Assessment Report (Arico, 2005) ecosystems services have four main categories which are provisioning, regulatory, supporting and cultural services. Provisioning services refers to benefits from the ecosystems that relate to things that enable human beings to subsist i.e. food, clothing and shelter. These are the most fundamental of provisioning ecosystem service. In its expanded form, provisioning ecosystem service includes the natural resources that are derived such as gold, timber and other mineral resources.

Regulatory services of ecosystems involve the maintenance of balance within the biosphere. An example is the water cycle or the carbon sequestration cycle. Closely related to regulatory service are support services. Support service benefit of ecosystems involve providing spaces for living things and maintaining biodiversity. The support services also include providing a healthy environment for human beings to thrive.

The last ecosystems benefit outlined by the MA (2005) is cultural services which include the non-material benefits that we derive from ecosystems and they include education, life teaching among others.

2.7 Cultural Ecosystem Services

Cultural Ecosystem Services (CES) are a crucial but remain an understudied component of the ecosystem services framework (Gould & Kekuewa, 2017). Understanding and conceptualising cultural ecosystem services is fraught with nuances due to the nebulous nature of the term culture. Satterfield et al. (2013) have described cultural ecosystems as a paradigmatic class of service which has emerged as a concept that is to be understood in terms of their life-enriching and life affirming contributions to the human well-being and a salient example of the way culture is generally embraced as an important variable in environmental resource management. It is worthy of note that an important body of grey literature has emerged with the aim of attempting to conceptualise cultural ecosystems services in different policy, practice and geographical contexts. The work of the UN Sub Global Assessment Network which was initiated by the Millennium Ecosystem Assessment (2005), has a database of 80 assessment reports out of which two thirds relates to cultural ecosystems services and benefits. Other platforms where the concept of CES has received significant attention include the European Union and the Intergovernmental Platform on Biodiversity and Ecosystems Services (IPBES). The IPBES for instance refers to the cultural services, provisioning and regulating as "Nature's Gifts" to reflect cultural differences and demonstrates how the relationship between human and non-humans are conceptualised. In spite of the significant effort at developing a common understanding of the concept of CES the subject remains an on-going debate and an agreed definition remains begging.

Cultural ecosystems services are the non-material benefits people obtain from the ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences and cultural diversity (Arico et al., 2005).

The millennium ecosystem assessment synthesis report (2005) notes that the use of cultural ecosystems services has increased significantly but the ability of the ecosystems to provide these services have been significantly impacted due to changes that are occurring within ecosystems. Human cultures are defined or strongly influenced by ecosystems. Ecosystems changes also affect cultural identity and social stability of many people-"Human cultures, knowledge systems, religions, heritages values, social interactions and the linked amenities (Arico et al., 2005). These important benefits are eroded either as a result of ecosystem changes or a reduction in the availability of ecosystem functioning or health.

2.7.1 CES Indicators and Perspectives

An indicator can be defined as a measure or standard based on verifiable data that conveys information about more than itself. Indicators are mostly measured against an index which is a numerical scale for comparing variables with one another or some reference number (Biodiversity Indicators Partnership, 2011). Alternatively, an indicator can be described as a component or a measure of environmentally relevant phenomena used to determine or evaluate environmental conditions or changes or to set environmental goals. An indicator can point out the direction of change across different units and through time when this is measured at regular intervals. Indicators also help in setting policy priorities benchmarking and measuring performance of ecosystems

The development of meaningful indicators for ecosystems services has engaged the attention of researchers and practitioners in the ecosystem arena for decades. This interest is underscored by the fact that for any meaningful valuation or assessment of cultural ecosystem services to be carried out, indicators are indispensable. The measure of indicators helps to determine the optimum level of utilisation and more so the improvement or deterioration of human welfare rest on our ability to measure the aggregate value of cultural ecosystem services (Costanza et al., 1998). The earliest attempt at developing indicators for cultural ecosystem services can be found in Costanza et al (1998) which categorised cultural ecosystems services indicators into two. These were Recreation and Culture. Since then, the development of indicators for CES has evolved significantly. Reviewing the various typologies in the literature, Gould & Lincoln (2017) observed the most frequent of typologies as shown in table 1 below.

Table 1 : Cultural Ecosystems Service Indicators as Expanded by Gould & Lincoln (2017)

Cultural Ecosystem Services	Constanza 1997	DeGroot 2002	MEA 2005	Boyd 2006	Raymon d 2009	deGroot 2010	UK Nat. Ecosystem Assess 2011	Chan 2012	CICES 2013	Milcu 2013
Spiritual	√	√	√	√	√	√	√	√	√	√
Recreation	√	√	√	√	√	√	√	√	√	√
Aesthetic	√	√	√	√	√	√		√		√
Artisitic	√	√	√		√	√		√		√
Cultural Heritage			√		√	√	√	√	√	√
Education	√	√			√	√	√	√	√	√
Social Capital/Relations			√		√			√		
Sense of Place			√		√			√		√
Existence				√	√			√		√
Knowledge Systems			√		√					√
Cultural Diversity			√		√					√
Identiy			√			√		√		
Bequest				√						√

From table 1 above which is based on the study by Gould and Lincoln (2017) it can be observed that while some of the terminologies used in the various studies vary slightly, they are essentially the same in meaning. The two typologies that ran throughout the various studies under review are Spiritual and Recreation. Apart from these two typologies (spiritual and recreation) none of the studies captured the entirety of the typologies. The studies that covered the most typologies were three and they include Raymond et al (2009); MEA (2005); and Milcu (2013) even though amongst them there are slight variations in the typologies.

Both researchers and practitioners in the ecosystem space have contributed significantly to the conceptualisation of the cultural ecosystem discourse. In the area of categorisation, immense efforts have been made to expand the indicators or the categories of CES. The progress made in this sphere notwithstanding there are difficulties with the attempt to reduce culture to specific categories. These categories obscure important aspects of a peoples' dependence on ecosystems for cultural services. Often times, these services are embedded in other services such as provisioning. To decouple these embedded cultural benefits is important if we are to identify complete cultural ecosystem benefits.

Even if we are to accept the categorisation by Gould & Lincoln (2017) as basis for any meaningful analysis, the benefits people derive from ecosystems by default of their livelihood is unaccounted for as the cultural ecosystem services. These are embedded in the livelihood activities people undertake in their daily lives such fishing, farming and hunting. These benefits are expressed and can only be described by the people who experience it. For example, while a fisherman may depend on fishing as a livelihood source, there is some fulfilment derived from fishing apart from the livelihood which gives the individual involved some satisfaction. This is unaccounted for and rightly so because it is embedded. It is an experience and a satisfaction which is beneficial to the actors involved. It is a feeling of accomplishment and enjoyment. This type of benefit is what is referred to as ‘experiential benefit’. This category of benefit forms the basis why the provision of alternative source of livelihood is not sufficient basis to remove people from their place. It is also the reason why in the face of devastating consequences of environmental change, people still appear ‘rooted’ in their place until such an occasion that they are ruthlessly ‘uprooted’. It is at this point that people develop mechanism to endure the effects of these environmental changes on their circumstances.

Secondly, if the idea of cultural ecosystem services is to be properly conceptualised, then the term ‘culture’ must be put in perspective. If culture is understood as a complex whole which includes knowledge, belief, art, morals, law, customs, and any other capabilities and habits acquired from human society (M. T. Johnson, 2013), then cultural ecosystem services must be expanded to include domestic services as activities under domestic services shape people’s way of life as far as ecosystems are concerned. This becomes even more significant as in less developed economies it is difficult to detach daily routines from ecosystems such as cooking, bathing, wood collection and some religious activities. These daily routines and their linkage with ecosystem service in rural communities to a large extent constitute cultural ecosystem service based on the basic understanding of the term culture and they are shaped by the ecosystems. It is through these daily dependence on the ecosystems that people develop indigenous knowledge, taboos and totems which become peculiar to them and their environment.

2.7.1.1 Place and Place Identity

Rootedness involves the intimate linkages between people and their place. Rootedness is perhaps the most important yet the least recognised needs of the human soul (Weil, 1987). The idea of nativeness and places become intricate as people identify themselves with territorialised homelands, cultures and origins. The assumption of linking people to places is not merely territorial but deeply metaphysical because people consider themselves as being rooted to places and derive their identities from places. The relationship between people and places can be conceived in specifically botanical metaphors (Malkki, 1992). This is evident in many nationalist discourses that link people to places in arborescent metaphors. This is not different from metaphors of kinship which seeks to demonstrate the natural relationship between people and places. Example is the use of the terms motherland and fatherland which aside their historical connotation also suggest the nation of grand genealogical tree (Malkki, 1992).

The notion of place can also be viewed as spatial segmentation and is built in the lens of cultural relativity and reflects not only narratives of cultural diversity but also in internationalist celebration of diversity in the “family of nations” (Malkki, 1992). It is in the light of this understanding of the relationship between people and places that the idea of ecological immobility emanates. In spite of the importance of place in the discourse of rootedness, academic and lay discussions on place are dispersed and multifaceted. Scholars and researchers use the term place in a variety of interdisciplinary, complex and ways that are sometimes contradictory (Dickinson, 2011). Place is a physical, cultural and even imaginary location that is differentiated and emotionally meaningful to people (Casey, 2009; Massey, 2005)

"Places are unique, different from each other; they have singular characteristics, their own traditions, local cultures and festivals, accents and uses of language; they perhaps differ from each other in their economic character… it couldn't be anywhere else" (Massey & Jess, 1995: p46). It is important to distinguish 'Place' from 'Space'. Unlike Place, Space is thought of as an undefined, abstract and unbound phenomenon but mediated. Both terms are sometimes used interchangeably and also depend on each other for definition by helping to understand how they are used to emphasis the difference in how physical situatedness is experienced (Dickinson, 2011). People experience place or places in varied ways and through these experiences, people develop a sense of place and form identities that leads to attachment. Place identity and Sense of Place therefore become important constructs that need to be deeply understood.

Globalisation is normally associated with the compression of space and reduction in time and the cost of transportation of goods and services, people and ideas across space (O'Brien & Leichenko, 2008) is likely to influence our understanding and conceptualisation of place in its traditional sense. This becomes even more certain if place is understood as the product of society (Doreen Massey & Jess, 1995). In the first world, notions of place have been disrupted as a result of increasing globalisation and time and space compression (O'Brien & Leichenko, 2008) and these processes are changing materially and determining how place is defined.

Notions of Place as different, separable and bounded areas within a larger whole called space are changing significantly. Stepputat (1994) in his study of the repatriation and the politics of space which explores the meanings of return and repatriation among Guatemalan refugees who were returning to Mexico observed that mobility of people, goods, capital, and ideas and the concomitant erosion of spatially bounded social worlds has been conceptualized in theories of postmodernity as deterritorialization.

In spite of the contrasting views Gupta & Ferguson (1992) have noted that globalisation has not diminished the importance of space or Place and the desire of people to consider themselves territorially different from other never been greater (Kibreab, 1999). Place has often been associated with identity and people get attached to places and places give people their identities is prevalent in the literature (Stedman, 2003). Place are territorialised or controlled by individuals or group (and states) to affect, influence, or control people, and relationships, by delimiting and asserting control over a geographic area (Sack, 1988).

2.7.2 **Aesthetics**

In dealing with cultural ecosystem attributes, one of the significant factors is aesthetics (MEA, 2015). Aesthetic value of cultural services refers to the interaction of people with the environment related to natural beauty based on human perceptions and judgments (Wagner & Alfaro, 2015). Aesthetic value refers to the value judgement which is dependent on the appearance of a particular object and the emotion it evokes. Aesthetic values are derived from several landscape attributes and determined by the interaction people have with their environment in relation to the natural beauty, perceptions and judgements. Aesthetic value has inspired culture, art and design in all parts of the world (Wiehl & Manns, 2014). People’s connections with particular landscape invokes in them a feeling which though subjective and solipsist, is a source of aesthetic benefit (Budd, 2000)

Aesthetic benefit of ecosystem has been studied from different points of view and disciplines. Stamps (1999), Dramstad et al (2006) and Norton et al (2012) have all studied aesthetics value of ecosystem from different viewpoints. While Stamp (1999) advocated for the planning professional to consider social factors such as aesthetic value in their decision making, Norton et al (2012) measured ecosystems services using national survey of biophysical components and experimental qualities of landscape in England.

Aesthetic appeal to a coastal area is its landscape characteristics. Landscape is an asset for the economy but more importantly, for the local community because it impacts on the life qualities of local people and is the perceptible embodiment of interrelated physico-natural and socio-economic system in which human being interact (Depellegrin et al., 2012). It has been argued that aesthetics affects human well-being and even health gain (Arico et al., 2005). Aesthetic value of ecosystems are important because apart from the intrinsic value, they are important in terms of recreation, conservation and tourism (Figueroa-alfaro & Tang, 2017).

Ecosystems around the world are being altered significantly due to the impact of climate change (MEA, 2014; IPCC 2014) with severe consequences for the aesthetic value of cultural ecosystem services. Nomikos (2018) and Bradly (2014) have predicted that with climate change, aesthetic value of ecosystems will be altered. The ecosystems with the most significant aesthetic value have become vulnerable and will become one of the most topical issues in ecosystems discourse in future. New approaches to understanding the relationship between humans and their environment in terms of the aesthetic values will be indispensable (Figueroa-alfaro & Tang, 2017).

Measuring and analysing aesthetic value presents major challenges due to the absence or lack of acceptable aesthetics indicators. Unlike other environmental issues which have well developed parameters for assessment, a conceptual framework for determining aesthetic value is weak (Tveit et al., 2006). This weakness can be attributed to the difficulty in measuring aesthetic value in quantitative terms. In spite of this weakness, it is important to mention that there is a growing interest in research in this area. The most commonly used framework for analysing aesthetic qualities is the Landscape Character Assessment Model.

2.7.3 Recreation

Recreation is an ecosystem service defined as the pleasure people derive from natural or cultivated ecosystems (MEA, 2005). Recreation has been pointed to as a cultural ecosystem type which is very important because public demand for recreational environment as relief from solitude, boredom and an escape from the hustle and bustle of everyday life and an opportunity for experiences is increasing (Kyle et al., 2006). What people experience in the environment is largely dependent on the characteristics of the natural environment and people are interested in different experiences including relaxation, nature and landscape enjoyment and self-experience (Kyle et al., 2006).

The dependence on cultural ecosystem services such as recreation which is experienced through human cognition and perception increases as places become more urbanised with agricultural intensification and this demand on cultural services is not the same with other ecosystem services because cultural ecosystem services is more difficult to replace when degraded (MEA, 2005). Loss of recreation resulting from coastal flooding and erosion are considered to be one of the major threats to the ability of the ecosystem to provide recreational opportunities (Metzger et al., 2006).

Another problematic area of recreational ecosystem service is the assessment method even though there is a growing body of studies in this area. Assessment still remains challenging because of the subjective nature of the variables such as human perceptions and preferences that require the analysis of societal values (Plieninger et al., 2013).

2.7.4 **Cultural Livelihoods**

A review of literature shows that the concept of the cultural livelihood is alien to the discourse of cultural ecosystem services. While the notion of livelihood conceptually is aligned towards provisioning as an ecosystem service, the conceptual underpinnings of the cultural livelihood is virtually non-existent. Generally, livelihood is explained to mean the making of living and constitutes the meeting of basic necessities of life (Fallis, 2013). It also comprises the assets and capabilities that are needed for the realisation of these basic necessities of life. In a typical livelihood framework, the asset stocks of a community comprise natural capital, social capital, financial capital and human capital. Sometimes, mention is made of political capital (CARE, 2002, Calvi, n.d.).

Notions of sense of identity that drives the feeling of belonging and serves as a catalyst for driving wellbeing is missing in the discourse of livelihood. If the cultural context within which livelihood is realised is to be understood, the concept of cultural livelihood needs to be explored. If Sense of Place is associated with the biophysical environment including how people are emotionally connected to place (Stedman, 2003) then Cultural livelihood is the satisfaction people derived from the pursuit of activities that are undertaken routinely and from which fulfilment is derived other than economic or subsistence. It comprises of the various environmental characteristics that help a people to craft their way of living. Thus, at the personal level, it constitutes fulfilment from employment and at the community level, it constitutes those norms, taboos, festivals and other cultural elements that define who a people are.

Cultural livelihood supports both the individual and the community in realising their aspirations. In many coastal communities especially in Ghana, customs and traditions of coastal dwellers are defined and shaped by the ecosystems in their environment. The customs and traditions define the community and its people. Different ethnic groups along the coast in Ghana have their unique cultures, taboos and custom in spite of the fact that there might be some similarities.

As far as cultural livelihoods are concerned, it is important to stress that point that there is a strong connection between flooding and its implications on gender. A study by Rakib et al. (2017) revealed that majority of the people are directly affected by the destructive consequences of flood hazards. The effects vary across socially differentiated gender and sectors such as education, security and infrastructure. Their study showed that gender variability is significant value in terms of flood disaster risk reduction, household development, and family caring activities. Consequently, it is recommended that development of resilience in flood prone areas should focus on building the capacity of women to adapt to flood hazards.

2.8 The Sustainable Development Goals (SDGs)

In reviewing the literature on coastal flooding and cultural ecosystems services, it is important to situate them within the context of the sustainable development goals which is the guidepost accepted by most countries as transition to sustainable development which has eluded the international community since the earth summit in 1992 (Blanc, 2015).

The Sustainable Development Goals (SDGs) are a set of integrated goals that take into account various national realities, capacities and national development and policies and which have been accepted by countries to improve the planet, ecosystem and "mother earth" (United Nations, 2015). The SDGs is a culmination of the decision taken at the Rio+ Conference in 2014. The SDGs is a sequel to the Millennium Development Goals (MDGs) which had 8 goals and spanned a period of 15 years. The MDGs were agree and accepted following the Millennium Summit of the United

Nations in 2000 after which the United Nations Millennium Declaration was adopted. While the MDGs were limited in scope, the SDGs are broader and more ambitious in terms of targets and aggressive in terms of approach. One of the limitations of the MDGs which the SDGs seeks to correct is that integrating the goals at various levels was lacking and was a key concern at the Rio conference.

There are seventeen goals in all and they include the goals of ending all forms of poverty hunger across the world and ensure food adequacy through enhanced agriculture. It also includes ensuring healthy populations and wellbeing and education for all. The goals aim at achieving gender equality and improve the condition of women and girls and ensuring the availability and sustainability of water and sanitation. The other goals are: ensure access to affordable, reliable, sustainable and modern energy for all; to promote sustained, inclusive and sustainable economic growth, full and productive; to achieve employment and decent work; to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; to reduce inequality within and among countries; to make cities and human settlements inclusive, safe, resilient and sustainable; to ensure sustainable consumption and production patterns; to take urgent action to combat climate change and its impacts; to conserve and sustainably use the oceans, seas and marine resources for sustainable development; to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably; to manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; to promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; and to strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development (United Nations, 2015).

UCLG (2018) emphasises the important of culture and by implication cultural ecosystem in the discourse of sustainable development goals. While no explicit references are made to Culture in all seventeen goals, there are subtle references in some of the targets i.e. 4.7, 8.3, 8.9, 12b and 11.4. Target 4.7 make reference to the appreciation of cultural diversity and recognises the contribution of culture to the sustainability agenda. Target 8.3 advocates for the promotion of development-oriented policies to support productive activities, creativity and innovation. Targets 8.9 and 12.b aims to devise and implement policies to promote sustainable tourism, including through local culture and products. Target 11.4 highlights the need to strengthen efforts to protect and safeguard the world's cultural and natural heritage (UCLG, 2018) . The enhancement or otherwise of cultural ecosystem services have implication for the realisation of the targets. In spite of the cultural connections that have been identified, there are immediate connections that can be identified between cultural ecosystems service and the SGDs. Goals 1,3, 11 and 15 have direct relationships with culture and cultural ecosystems services.

2.9 Interlinkages between Coastal Flooding and Cultural Ecosystems Services

The framing of global environment change, coastal environment change, flooding and cultural ecosystem services are connected at the conceptual level. The diagram below shows the interlinkages among the various concepts and shows how cultural ecosystems services are impacted as global environment changes. The intermediary factors between global environmental change and cultural ecosystems services which are the coastal environment change with its drivers and flooding have significant impact on cultural ecosystems services (Figure 1).

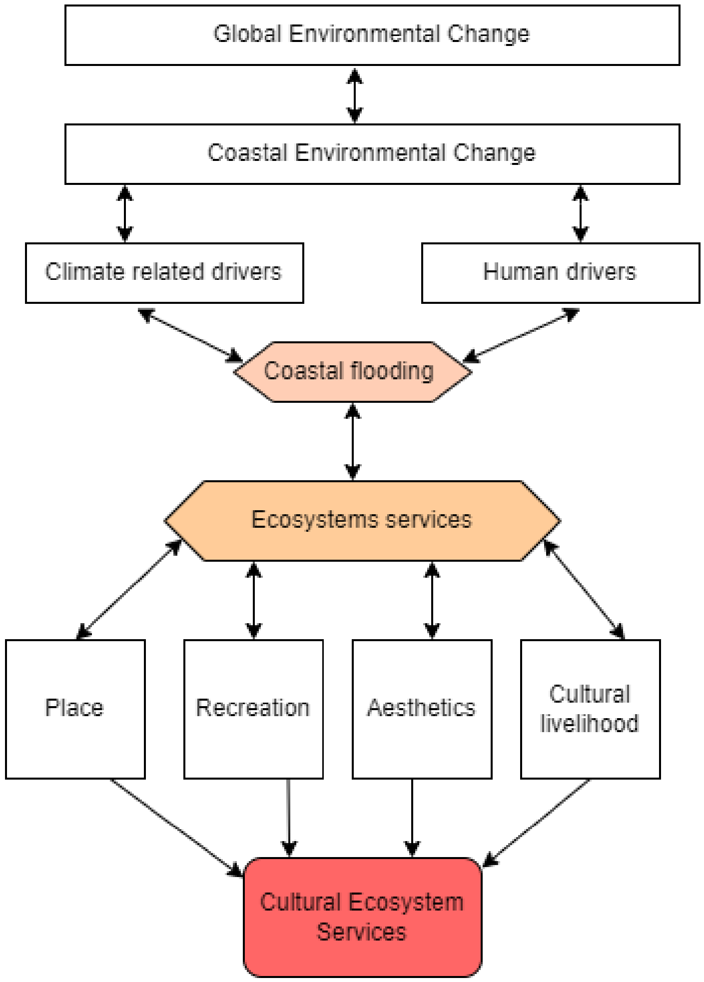

Figure 1: Interlinkages between global environmental change, cultural ecosystem services and coastal flooding

Figure 1 shows the linkages between global environmental change and cultural ecosystem services. The changes in global environment driven by the forces of globalisation, consumerism and high economic growth as postulated by O'Brien & Leichenko (2008) has consequences for the cultural ecosystem services. As mentioned above, increased globalisation and global trade have implications for global climate drivers such as increases in atmospheric temperature and ocean climate which contribute to global warming. Changes in global environment also mean coastal areas including coastal ecosystems such as wetlands and aquatic ecosystems will be lost (Nicholls, 2004: Talbot et al., 2018).

It is important to indicate the relationship among the various variables are not uni-directional. Some of the relationship also move in reverse directions. Loss of ecosystems such vegetation in coastal areas can also lead to coastal flooding or exacerbate the effects of coastal flooding. In many instances, vegetation such as mangroves serve as a barrier to reduce the force of water that approaches landward. In addition, coastal areas become urbanised without proper architecture to prevent flooding, the likelihood of flooding will be high. It is important to mention that high population growth and high population density in coastal areas can also lead to flooding.

2.10 Summary of literature review

Coastal flooding has significant impact on key cultural ecosystem variables which are cultural livelihood, aesthetics, recreation and place and sense of identity (Burley et al., 2007). The dynamics of the relationship between coastal flooding and the impact on the cultural ecosystem services mentioned above needs to be explored in detail. For example, while both climatic and non-climatic drivers affect flooding, there could be instances where non-climatic drivers become mediating variables that compound climatic drivers and the vice versa. These dynamic relationships have not received significant attention in the literature and needs to be further research.

From an ecological perspective, coastal areas are hotspots of biodiversity as they host diverse abiotic conditions and are subject to dynamic disturbances leading to a mosaic of many specific habitats and species (Stammel et al., 2021). Severe coastal floods may bring risks to settlements, infrastructure, and other land use types and cultural ecosystem services. More especially, because the cultures are different from one location to the other, understanding the relationship between coastal flooding and cultural ecosystems services in Ada in particular will go a long to filling aspects of the gaps in the cultural ecosystem discourse. A key aspect for instance will be identifying additional variables for the cultural ecosystem suite.

The benefits of using a probabilistic problem to inform decision making as far as environmental issues are concerned cannot be understated. In the area of cultural ecosystem services, studies on the application of models to predict the future outcomes of or status of cultural ecosystems services are few studies. This is also justified by the fact that cultural ecosystems services as a research area has not been widely studies was the literature revealed. Application of the Bayesian model to predict the future implication of coastal flooding for cultural ecosystems will also contribute effect decision making.

2.11 Review of Methodological Approaches

2.11.1 Structural Equation Model

Structural Equation Model as a tool for analysing the relationship between and among variables has gained prominence among researchers in recent times (Lei & Wu, 2007). Structural equation modeling, or SEM, is a very general, chiefly linear, chiefly cross-sectional statistical modeling technique. Factor analysis, path analysis and regression all represent special cases of SEM. SEM is a largely confirmatory, rather than exploratory, technique. That is, a researcher is more likely to use SEM to determine whether a certain model is valid, rather than using SEM to "find" a suitable model--although SEM analyses often involve certain exploratory element.

Structural Equation Models were born out of the need for greater flexibility in regression models which are restrictive. SEM is a multivariate statistical model that is used in analysing the relationships between multiple variables (Olio & Oña, 2018). It is an extension of general linear models like ANOVA and Multiple regression analysis. SEM is also referred to as a confirmatory analysis because it is used to determine whether hypothesized theoretical model is consistent with the data collected to reflect the theory. This confirmation is evaluated through the model-data fit which determines the extent to which assumed relationships between variables is plausible.

SEM involves three models which are the path model, the measurement model and other models. The Path Model is a form of multiple regressions that computes the coefficients of the various equations. It provides an effective way of modelling mediation, indirect effects and other complex variables. The second model which is the measurement model involves the measurement of latent variables which cannot be directly measured because they are not observable. These unobservable variables are measured based on responses of the participants in a study. The measurement of the latent variables has its origins from psychometric theories. The measurement model is evaluated by conducting confirmatory factor analysis (Lei & Wu, 2007). With the measurement model, the hypothesis is formulated a priori and not from data and then verified empirically as opposed to the vice versa. The other models in the linear equation models include modelling the mean structures, the growth models (growth over time), latent class or profiles *et cetera*.

SEMs have been applied in a wide range of fields such as psychology, sociology, biological sciences, educational research, political science, market research, etc. SEM follows a systematic process which involves five steps. It begins with the model specification where the variables are identified and define. This process is based on detailed literature review to identify the variables and then secondly to understand the relationships among the variables. This process can also be done graphically. The second step is the review the data characteristics required for the model. An important consideration is the sample size required to ensure that the model fits well. The sample size is important because SEM is a large sample size technique. The other steps are the model estimation and evaluation. The model estimation phase involves running the model to ensure convergence. The model estimation uses the maximum likelihood estimate. This is where all possible paths are showed and all paths that are not possible are scaled to zero. The model evaluation phase involves interpreting the results to see the extent to which the model fits the data.

Is spite of the important of SEM in understanding the relationship between variables, it is limited in its ability to determine causal relationships among variables. The conditions necessary to predict causal relations include time precedence and robust relationships in the presence or absence of other variables.

2.11.2 Application of GIS and Remote Sensing to Historical Shoreline Analysis and Vegetation Change

Unreliable information and poor methods of analysing spatial and temporal information in environmental science can have dire consequences for effective and sustainable management of the environment in general and ecosystems in particular. Globally, remote sensing has received notoriety as being significant source of data for environmental research and GIS has been an effective tool for data analysis, storage and presentation (Harris, 1998). Remote sensing is generally defined as a method of data acquisition from the earth's surface without physical contact while GIS is defined as a set of tools that enables collection of data, storage, retrieval, analyses and presentation of geographical referenced information (Opolot, 2013).

The geographic interface of littoral areas and of shorelines and the hydrodynamics of occurrences and their effects have made shoreline changes one of the important processes of coastal areas (Tamassoki et al., 2014). Shoreline Change is one of the most common natural processes that occur in most coastal areas. In the management of shoreline changes and its effects on coastal landscape, it is important to monitor the rate of shoreline movements with the view to determining the appropriate management and policy option to reduce the extent of impact on coastal dwellers and coastal infrastructure.

It has been argued by Dolan et al (1991) that the extent to which shoreline estimates reflects actual changes and accurate future projections is dependent on several factors which include the accuracy of current or present positional data, the temporal changes in shoreline movements, the number of measurements factored into calculation, bias arising from sampling, the intervals between measurements, the duration of the record being used and more importantly, the method being used in the calculation of the rate of change (Dolan et al., 1991). In monitoring shoreline movement using the rates of change over a period, several methods are used. They include End Point Rate (EPR), Linear Regression, Jack Knifing (JK) and Average of Rates (AOR). Others include reweighted least squares (RLS), Weighted Least Squares (WLS), Least Absolute Deviation (LAD), Weighted Least Absolute Deviation and Minimum Description Length (Genz et al, 2007).

2.11.3 Digital Shoreline Analysis System (DSAS)

The Digital Shore Line System (DSAS) is a GIS tool that is used in Historical Trend Analysis (HTA) to examine past and present shoreline positions. DSAS has the advantage of being able to compute rates of changes statistics from time series data which can be evaluated in terms of shoreline dynamics and change in trends. This system has been deployed in many studies (Appeaning Addo & Adeyemi, 2013, Appeaning Addo, 2014, Boateng et al., 2017).

The process of using DSAS has several steps as outlined by Himmelstoss et al., (2018). First and foremost, the specific features of interest are extracted through digitization and this can include shoreline position or mean high water level etc. Shoreline positions can also be obtained from satellite images or digital orthophotos etc. Accurate and careful digitisation of shoreline positions is recommended in spite of the evitable limitation of error associated with digitization and synthesization of different quality of data which can be derived from different times and sampling intervals. Again careful digitisation is essential as shoreline change measurements accuracy are as reliable as the sampling of measurements (Oyedotun, 2014).

To the extent that any spatial or laboratory analysis has the goal of solving spatial problems, it is important to emphasise the need for data quality. The factors that affect data quality include logical consistency, completeness, scale, resolution and accuracy. Identifying these mapping uncertainties associated with shoreline mapping procedures is important so as not to reflect long-term trends which are not based on short-term variability.

DSAS measures shoreline rates based on the measured difference between shoreline positions related to particular time periods. The following statistical measurements are possible with DSAS. The Shoreline Change Envelope (SCE); this measures the total change in the shoreline position without taking into account their distance and positions. Net Shoreline Movement (NSM); reports the difference between the newest and the oldest shoreline. End Point Rate (EPR) is calculated by dividing the distance of shoreline movement by the time between the oldest and the youngest shoreline positions. The Linear Regression Rate (LRR) determines the rate of change statistics by fitting the least square regression (LSR) to all shorelines at specific transects. Other statistical measurements which are determined by DSAS include the Weighted Linear Regression (WLR), Standard Error of Weighted Linear Regression (WSE) and Least Median of Squares (LMS). The objective of the analysis to be investigated and the characteristics of the datasets determine the statistical method to adopt (Oyedotun, 2014).

DSAS is useful in historical measurements of changes in shoreline geometry and the identification and mapping of coastline erosion and accretion in coastal environment. The advantage of using DSAS is that it allows for errors to be accounted for in rates calculation. The need to account for errors arise from the fact that the method of assessing historical shoreline positions itself is prone to errors from different sources including errors from measurement and image processing (Genz et al., 2007). These merits notwithstanding, DSAS has the limitation of not being able to indicate the forcing that drives the observed dynamics (Oyedotun, 2014).

2.11.3.1 Accuracy and Reliability of Shoreline Estimates

Shoreline change rates are derived from time series of historical shoreline positions using different types of statistical tools. These tools are susceptible to errors which must be accounted. There are several methods for accounting for these errors.

The reliability of documented trends and calculated rates of shoreline positions depends on the following 1. Measurement errors which accounts for the accuracy of shoreline positions. Positional errors are important to the extent that they affect analytical precision especially in situations where a wrong shoreline position is assumed to be actual (Genz et al., 2007); 2. the sampling errors which also accounts for the variability and 3. Statistical errors which arise from the compilation and comparison of shoreline positions (Morton et al., 2005) . Additionally, several sources of errors affect the accuracy of historical shoreline positions and shoreline rates and create uncertainties. Apart from errors arising from shoreline positioning, researchers such as Manno et al (2017) have used hydraulic model or measurement of tidal fluctuations provides high accuracy in wave run-up calculation. This, they further argued can result in a more accurate error estimation as highlighted from comparison of the present model within situ run-up measurements (Manno et al, 2017).

Accounting for error in digital shoreline measurement is indispensable as it has implications for sound management decisions and research recommendations.

2.11.4 The Application of the Bayesian Network Model to Environmental Decision-Making

Barton et al. (2012) have noted the fact that environmental managers and policymakers require the assistance of models to enhance the quality of environmental decisions. The complex nature of environmental issues, problems and outcomes requires a model that is flexible and amenable to accommodate wide spectrum of knowledge at multiple scales and levels of resolutions. Duespohl et al. (2012) concur with this view when he notes that the complex nature of environmental issues and the uncertainties embedded in environmental decision outcomes has engendered significant interest in methods that can help in resolving these uncertainties. To understand the human-environment systems and to support the effective management of environmental resources, diverse knowledge sources have to be applied and the impact of these knowledge systems should be measurable by different stakeholders. Apart from the existing knowledge systems, the values, goals and perspectives of various stakeholders as well as common goals have to be considered (Duespohl et al., 2012). One of the decision methods which have gained prominence as a decision support tool because it satisfies the requirements above is the Bayesian networks model. The BN model has been applied to various research studies (Couture et al., 2018, Verweij et al., 2014, Keshtkar et al., 2013, Uusitalo et al., 2005, Henriksen et al., 2007)

Bayesian Networks (BN) is a model of selected real system that represents the systems components and relations in the form of a probabilistic causal network (Duespohl et al., 2012). BN consists of 3 elements which are the systems variables also known as the node, the causal relationships between the node which are seen through directed links which point from cause to effect and finally a set of conditional probabilities for each node which shows the strength of the causal relationship (Duespohl et al., 2012). BN models graphically and probabilistically show the relationships among variables and integrate multiple lines of evidence based on existing data and expert judgement to aid in environmentally related decision-making.

There are seven steps in the construction of the Bayesian network model which are worth understanding (Duespohl et al., 2012). The first step is defining the problem. Problem definition and situating the problem in context through stakeholder engagement should be done at the beginning of the process. The aims and scope should also be clearly spelt out at this stage (Chan et al., 2010). Secondly, the variables to be used in the model have to be clearly identified and the indicators of these variables have to be described in depth to ensure that the design is parsimonious and considers the most important of the processes and causal relationships. The next step is to develop the temporary network by starting small and progressively increasing the variables if necessary. Developing the network with stakeholders and experts from the beginning can make the process cumbersome and the model complicated. Having developed the pilot model, the next phase is to develop the Conditional Probability Table (CPT). The principle underlying the CPT is to understand the probability of a variable ‘A’, assuming the state of ‘X’ given ‘Y’ (Heckerman, 2008). It involves assigning of weights to variables or indicators by experts. Where there are differing weights from multiple experts, it is possible to find the average of the weights from two experts. The next step is to validate the consistency of the model be subjecting it to review by a more experienced modeller. Recommendation and feedback from stakeholders should be incorporated into refining the model. At this stage the final decision is made and can be tested in a group or individually (Henriksen et al., 2007). Once validation of the model is done, the model should be able to compute various scenarios. The sixth and seventh steps involve evaluating the success of the BN model and offering possible recommendation for the application of BN model.

As a decision support tool, the BN offers tremendous opportunities for researchers who are interested in conducting research on complex issues that cut across disciplinary boundaries. It is a good tool for conducting transdisciplinary research as it allows for the incorporation of wide range of disciplines and spheres and also practical experience from experts (Henriksen et al., 2007). It helps to identify gaps in knowledge. It enables the researcher to acquire first-hand knowledge of the environmental system under consideration due to the engagement of experts. BN also offers the benefit of holistically considering all possible scenarios including uncertainty (Uusitalo et al., 2005). This way, it reduces over confidence in the response to proposed interventions. BN model allows data from multiple sources and even where there is lack of data or incomplete data, the network performs the analysis. Lastly, BN modelling process is transparent because it brings together experts and represents uncertain knowledge in ways that transparent.

In spite of the numerous advantages in the adoption of BN, there are several limitations. The model has been criticised for not being dynamic enough when dealing with highly dynamic problems such as water resource management. Static spatial variability can be assumed by parent that has specific locations as states. Again, temporal dynamics can be presented by adding a number of BNs to dynamic BNs, but the number of ties is limited because of excessive computing times. The process of computing the CPT is cumbersome for stakeholders. Conducting probabilistic analyses and eliciting knowledge from scientific experts can be difficult because scientists have to rely on observational data in certain cases as opposed to actual data (Uusitalo et al., 2005). BN reliance on expert judgement or knowledge is prone to error due to the complex nature of environmental systems. Such errors can significantly affect the CPT thus making the model highly unreliable. The use of discrete variables such as 'low', 'medium' and 'high' produces imprecise and ambiguous results that are difficult to interpret (Duespohl et al., 2012). The limitations notwithstanding, the BN model continues to be an important tool in environmental decision-making and research.

CHAPTER THREE

3. Methodology

3.1 Introduction

This chapter presents the profile of Ghana, including the location and physical characteristics, demographics, economic features, land use and coastal features. It also characterizes the districts in which the study is located and delineates the study communities. The general approach to the study and its philosophical and methodological foundations are defined, the study communities described and sampling procedures, data collection process and data analysis methods outlined. Finally, the chapter indicates the limitations of the study and ethical considerations, including inclusion and exclusion criteria.

3.2 Location and Physical Characteristics

The study is based in Ghana (figure 2), located on the western coast of Africa, with a total land area of 238,540 km². The country lies between 4° to 12°N latitude and 4°W to 2°E longitude, has a north-south extent of about 670 km and a maximum east-west extent of about 560 km (Mantey, 2013). It is bordered in the north by Burkina Faso, to the west by Cote d'Ivoire, to the east by Togo and to the south by the Atlantic Ocean. Of the total boundary of Ghana, the coastline is about 550 km and of mostly low, sandy shores backed by plains and scrubs intersected with several rivers and streams. It is estimated that about 57% of the total land area of Ghana is used for agriculture (FAO, 2020; Fugar, 2020). Between 1975 and 2000, the area of land used for agricultural purposes increased from 13% to 28% and increase by 32% between 2000 and 2013 (Comité Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS), 2016).

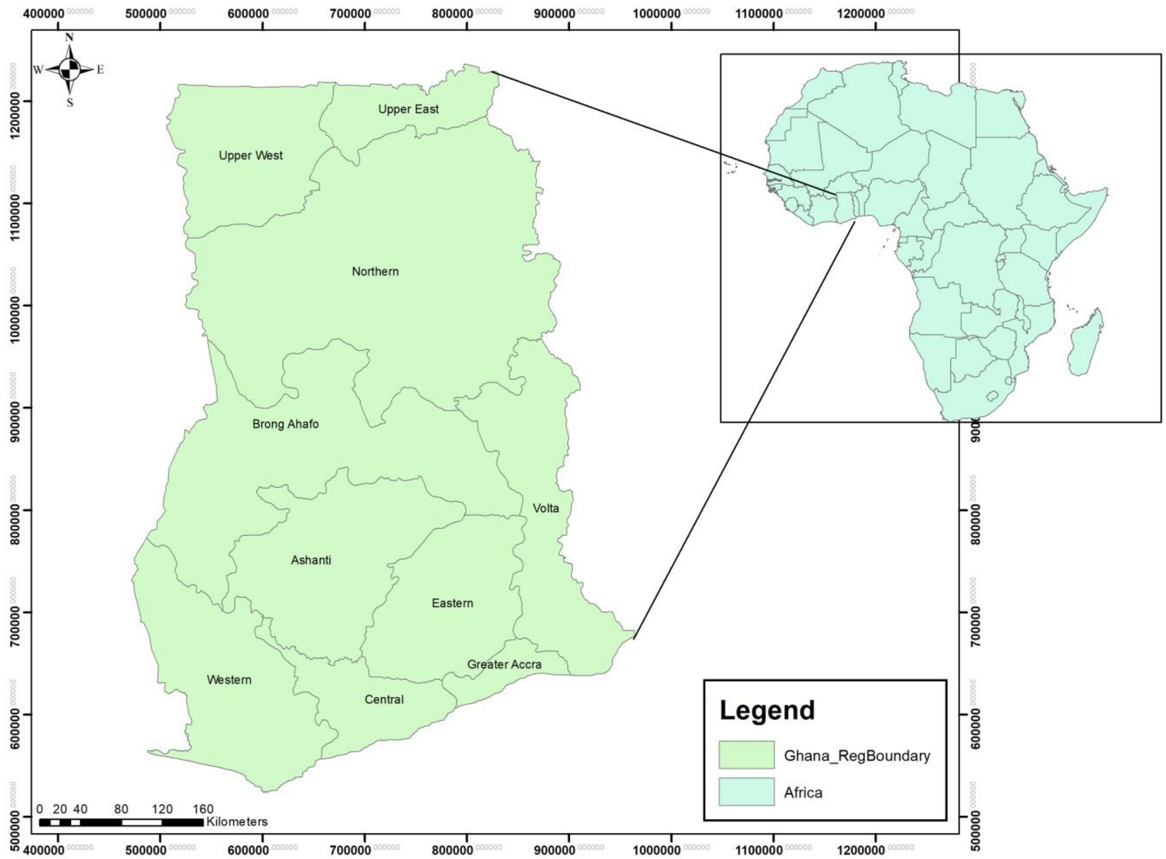

Figure 2: Location of Ghana

Ghana's climate is tropical and influenced by the West African monsoon winds. The climate is mostly warm, and temperatures vary according to the two key seasons; the dry season and wet season. Mean average daily temperatures range between 30ºC during the day and 24ºC during the night with relative humidity estimated at 77 percent to 85 percent. The wet season in the southern part of Ghana is bi-modal and occurs from April through June (major season) and September through November (minor season). In the north of Ghana, the wet season is unimodal (having single rainfall peak period). The rest of the period is dry season. Annual rainfall ranges from about 1,100 mm in the north to about 2,100 mm in the south-western part of Ghana (Logah et al., 2013). Ghana also experiences the *harmattan* (a season in the West African between November and

March when the weather is dry and dusty due to northeasterly trade wind which blows from the Sahara Desert over West Africa into the Gulf of Guinea) between December and January although the pattern has changed in recent times (Ministry of Foreign Affairs of the Netherlands, 2018).

3.3 Study Area

The Ada coastline disappearing at a rate of between 6-8 meters a year, which created a serious threat to the lives and livelihoods of the inhabitants (Boadu, 2014). Many people living along the coastline have been forced to evacuate their homes to safe places as the marauding sea waves approach. The main road in front of the Ada East District Assembly offices is gradually being washed away. The study area lies along the coast of Ada East and Ada West involves seven communities along the coast of Ada. The communities are (i) Wokumagbe, (ii) Akplabanya, (iii) Anyamam, (iv) Lolonya, (v) Totope, (vi) Azizanya and (vii) Azizakpe (Figure 3).

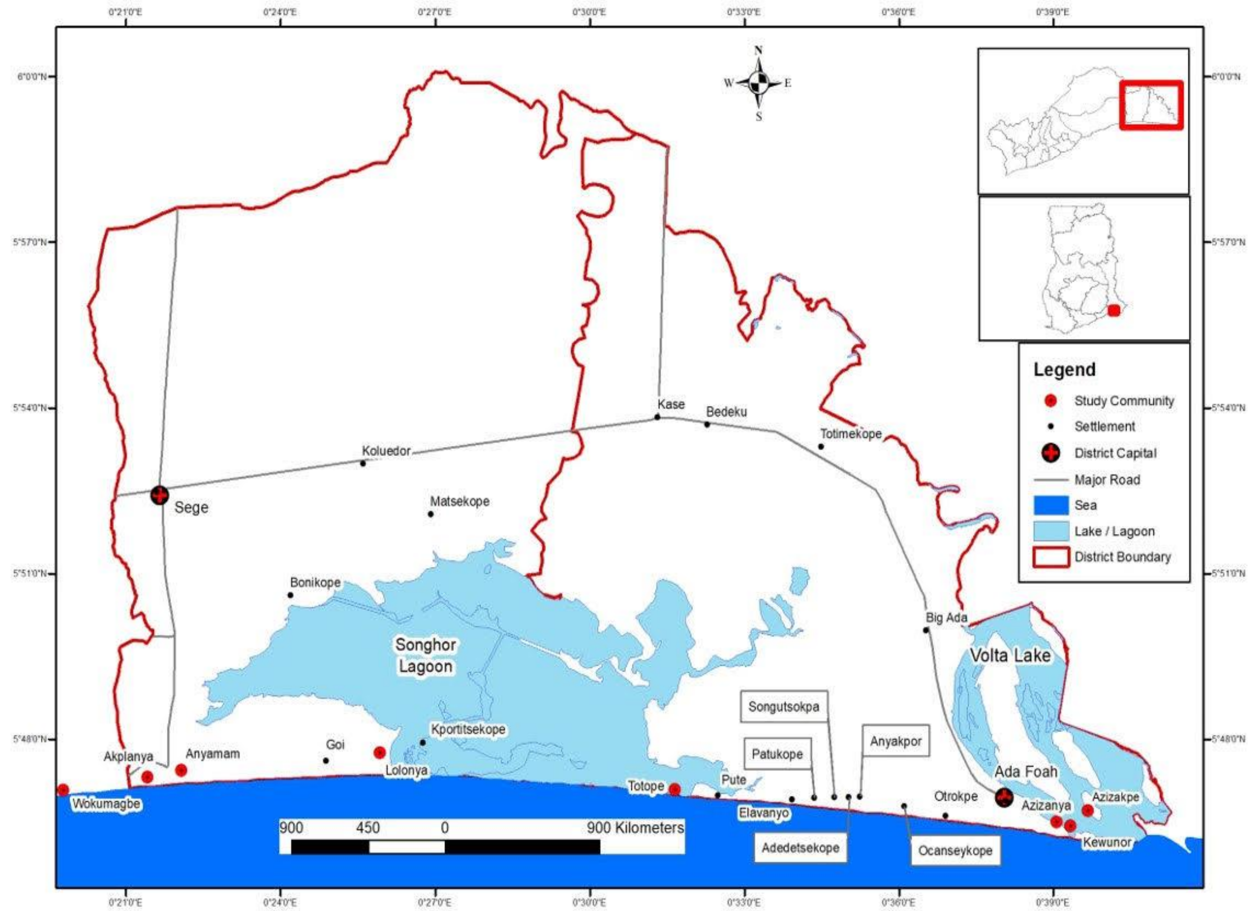

Figure 3: Map of the study area

Three of the communities, i.e., Kewunor, Azizanya and Azizakpe which share boundaries are located between the sea and the river, while Lolonya is located near portions of the Songhor Lagoon. Totope is also located between portions of the Songhor lagoon and the sea.

Ada East and West Districts were formerly Dangme East District, and was created in 1989 by Local Government Instrument, L. I. 1491. The new district (Ada West) carved out of Dangme East was created by subsection (one) of section three of the Local Government Act, 1993 (Act 462). The new Legislative Instrument *id est* (L.I 2130) in 2012 established new districts Ada East and Ada West. The study communities fall with the protected area which also hosts a Ramsar site and is regulated under the Wetland Regulation LI1615 of 1999. As a Biosphere Reserve, it is recognised by the United Nation Economic Social and Cultural Organisation (UNESCO) and other international organisations.

3.3.1 Topography, Minerals and Geology

The study area is a section of the Accra Plains and lies within the central portions of Accra plains. The relief is mostly gentle and undulating. Typically, the area has low plains with heights of about 60 meters (200 ft.) above sea level. The prominent relief features include the Tojeh boulders rising about 240 meters (800 ft.) above sea level and these boulders are scattered irregularly along the beach (District Planning and Co-ordinating Unit Ada East District, 2010). The drainage pattern is dendritic and some of the streams take their source from the Volta River. The area has a significant amount of salt deposit which contributes to the economic activity in the area. Recent unconsolidated sand, clay and gravel occur in the deltaic areas of the Volta River as well as in the areas surrounding the Songhor Lagoon at Pute (one of the communities in Ada) (Ghana Statistical Service, 2014). The rock of the basement is not known, but it is expected to be Dahomeyan, similar to that cropping out to the north of the basin (District Planning and Co-ordinating Unit Ada East District, 2010).

3.3.2 Vegetation

The vegetation reflects the coastal savannah typology and it is characterized by short savannah grasses mixed with shrubs and short trees. Along the coast, there are stretches of coconut trees and clusters of coconut groves. Strands of mangrove trees can be found along the tributaries of the Volta River where the soil is waterlogged and salty (District Planning and Co-ordinating Unit Ada East District, 2010).

3.3.3 Climate

Ada is encapsulated by the south-eastern coastal plains of Ghana which is one of the hottest parts of the country. Temperatures range between 23°C and 28°C and remain high all year round a temperature can go up to 33°C within the year (GSS, 2014). Rainfall is normally intense during the major seasons between March and September with average rainfall of about 750 millimeters. During the *harmattan* season however, the area is mostly dry with virtually no rainfall. Humidity in Ada is estimated at about 60% high and this is due to its closeness to the sea, the Volta River and other water bodies like the Songhor lagoon. Daily evaporation rates is between 5.4 - 6.8 millimeters (District Planning and Co-ordinating Unit Ada East District, 2014). High temperatures in the area help in the quick crystallization of salt which explains why many of the inhabitant produce salt as supplementary income (District Planning and Co-ordinating Unit Ada East District, 2010).

3.3.4 Social and Cultural Structure; the Origin of the Indigenous People

Ada is a Dangme-speaking area and people migrated into Ghana from the eastern part of the Volta river in the fourteenth or fifteenth century (GSS, 2014). Other Dangme-speaking people (or communities) are the people of Krobo, Osudoku, Shai, Ningo, Kpone and Prampram. According to Amate (1999) the place from which the ancestors of the Dangme speaking peoples came into Ghana was called Same (Amate, 1999). Other versions of the oral tradition say that Same was in southern Nigeria while some believe Same was in Dahomey, now Benin. After crossing the Volta River, the indigenous Dangme clans of Ada stayed at Lorlorvor. From Lorlorvor, they moved on to the Guinea coast to settle in a forest which they named Okorhue. The descendants of these migrants are referred to as Okorli, which is now used to refer to Adas. Another variance of Okorli is Adali. The people of Ada speak Dangme as their local dialect.

3.3.5 Dominant Economic Activities

The Ghana Statistical Service (2012) describes the district as predominantly an agrarian economy with a majority of the population (68.3%) living in rural setting. The market in Kasseh allows the people of Ada to undertake commercial activities Tuesdays and Fridays which are the markets days of the district. The Ada-Foah Market also allows people to trade on Wednesdays and Saturdays although patronage is lower than the Kasseh Market (District Planning and Co-ordinating Unit Ada East District, 2014). The district is endowed with tourist sites which include forts, estuary, holiday chalets, and beaches along the bank of the Volta River and Gulf of Guinea which serve as tourism sites for both local and foreign patrons. Some of the tourism facilities include ferry, jet ski and boat harbour at the river side where it can be rented for a cruise around the islands on the river. The district also has guesthouses, hotels and restaurants that cater to the tourism and hospitality industry (District Planning and Co-ordinating Unit Ada East District, 2010).

3.4 Research Approach

3.4.1 Trans Disciplinary Research

The inherent complexity of the relationship between nature and society requires the application of a research method that deploys an epistemological approach which cuts across disciplinary boundaries. In recent times cross-cutting research approaches such as multidisciplinary, interdisciplinary and transdisciplinary have emerged to fill this vacuum. It is important to state that this study employed a transdisciplinary research approach for understanding the complex issue of coastal flooding and the interlinkages with cultural ecosystems (Cronin, 2008).

Transdisciplinary research has been described as a field of research that has become important in the knowledge society and that attempts to link science and policy to address societal problems. It seeks to escape the narrow boundaries of disciplines and set new approaches that can generate new ideas. Unlike interdisciplinary research, which mainly involves academics, transdisciplinary research goes a step further to involve non-academics making it more participatory. Transdisciplinary research is interdisciplinary research made transparent.

Transdisciplinary research has been touted as a great tool for investigating and understanding complex issues because it introduces varied perspectives to complex issues. It helps to create new knowledge due to the hybridisation process that is created by the integration of disciplines. Because transdisciplinary research can involve different researchers from different cultural backgrounds, disciplines and areas of work, it enhances knowledge sharing and enriches the research experience.

In spite of the several benefits of transdisciplinary research, it is fraught with some challenges (Cronin, 2008). Barriers within the academic community, where some scientists prefer to conduct research with their disciplinary boundaries and may not want to confront issues and questions raised by researchers from other disciplines remains a challenge for transdisciplinary research. This challenge is compounded when funding agencies are unwilling to promote transdisciplinarity. Cultural differences among the participants of a transdisciplinary study and the fact that researchers have different backgrounds requires consensus building which can be time consuming (Hirsch et al., 2006). Finally, difference theories, methods and language from different disciplines can make communication difficult especially when it comes to problem definition (Petts et al., 2008).

To assess the interlinkages between coastal flooding, inundation and cultural ecosystem services, the study combined data from household survey, focused group discussions, participant observation but also more importantly, the study incorporated the views of experts. Various institutional experts and people with good understanding of the history of Ada and how the people have evolved participated in the development of the Bayesian model. Historical account of erosion, inundation and reclamation was also given by the traditional leaders who are custodians of cultural values some of which are derived from ecosystems. Some of the experts participated in the assessment of the status of cultural ecosystem services.

3.4.2 Mixed Method Research

The complex nature of environmental issues requires research approaches from different disciplines. In some cases, integrated methods are required to dully understand the ramification of a problem (Roudgarmi, 2011). This study uses mixed methods approach in research design, data collection and analysis. Mixed methods research is a comprehensive technique that uses both thematic and statistical data for collection and analysis (Tashakkori & Teddlie, 2003). It approaches both theoretical practical knowledge in a way that considers multiple viewpoints, perspectives, positions and standpoints (Johnson & Onwuegbuzie, 2007).

Mixed methods research use both inductive and deductive approaches to enquiry and thus enables researchers to undertake theory generation and hypothesis testing in a single study without comprising on either. With this approach, research can provide better inference when studying a phenomenon of interest. It is also useful when considering information from multiple data sources and analyses to create divergent views and outcomes. Again, by relying on mixed methods one is able to explain experiences and social occurrences which are mostly subjective in nature as opposed to reliance on statistical methods which may not suffice (Uma & Jaloni, 2011).

Mixed methods were used in the study because of the biophysical dimension. Thus, a mixture of quantitative and qualitative methods was used in data collection and analysis. Quantitative techniques were used to identify household survey sample and to compute some descriptive and inferential statistics. Qualitative methods were used to analyses the results. The type of mixed methods used in this study is "pure mixed" where quantitative and qualitative are given equal mix as espoused by (Johnson & Onwuegbuzie, 2007).

3.5 Data sources

Due to the biophysical nature of the research problem and its impact on households and communities, primary data sources were acquired through social surveys and biophysical data from secondary sources.

3.5.1 Primary Data Collection

Primary data was collected using three main formats, (i) household surveys, (ii) focus group discussions, and (iii) key informant interviews. Households were selected as the unit of analysis to understand and appreciate how flooding affects households. Structured questionnaires were used and followed by in-depth interviews that were conducted through focused group discussions. In addition to the household interviews and the focused group discussions, key informant interviews were conducted.

3.5.1.1 Sampling Design

Sampling is an important part of any research enquiry (Onwuegbuzie, 2007). Even more important is the technique that is deployed for the sampling. This stems from the fact that the validity of the generalisations that are made from the finding in a study depends on the potency or appropriateness of the sampling method (Tashakkori & Teddlie, 2003).

A three-tier sampling technique was used in the study. Firstly, purposive sampling was used to determine which communities to include in the study based on the characteristics for inclusion. The study aims to explore the impact and interlinkages between coastal flooding and cultural ecosystems services so communities which are affected by flooding were selected based on initial discussions with communities about coastal flood experience. Secondly, simple random sampling was used to select households to participate on the study. Due to the likelihood of simple random sampling being roughly randomly ordered or might lead to the concentration of households in a particular area, systematic sampling was used to determine the interval between households in the random sampling. A random integer of five (5) was chosen to randomly generate the household identification number.

In all, there are seventeen communities that fall within the study area with an estimated population of 60, 265 people and approximately 10,608 households (District Planning and Co-ordinating Unit Ada East District, 2014; GSS 2014). A representative random sample of the population was selected from the population and used in the survey.

The sample was determined using Yamane formulae (Yamane, 1967) because of its suitability for determining sample for large populations and the fact that the sample derived from the formulae was considered representation. The formular is given as follows;

$$n = \frac{N}{1 + N(e)^2}$$

Equation 1: Sampling formulae (Yamane, 1967)

Where:

$n =$ sample size

$N =$ population size

$e =$ the level of precision or confidence interval (0.05)

Based on Yamane's computation, a total of 385 households were used for the study. Demographic information on the households, cultural ecosystem service dependence and impact of flooding on cultural ecosystem services were collected and analysed.

3.5.1.2 Inclusion and Exclusion Criteria

The study involved people above the age of 13 years who have been resident in any of the communities for not less than a year. The age limit is discretional and based on the assumption that by 13 years, the child will have reached Junior High School and will be capable of expressing him or herself. The residing period is set to ensure that the person might have gone through a full seasonal cycle. The study excludes children below the age of 13 years and who have not been resident for about a year.

3.5.1.3 Ethical requirements and consent

Ethical considerations in a research study are indispensable. Rigorous ethical procedures were followed to ensure that all possible confidentiality violations and risks are addressed or mitigated. To this end, the study was subjected to ethical review by the Ethics Committee of the College of Basic and Applied Sciences. The study recognized the need to protect the confidentiality of personal identifiers such as name, date of birth and telephone numbers therefore, these identifiers were protected to ensure that they do not become available to persons or groups of persons at any time during and after the research. Written consent of the various participants was sought prior to the commencement of the study. The Protocol Consent Form was also submitted to ethical review for approval.

The study also recognised potential risks such as emotional stress arising from members of the community remembering unpleasant incidents, anxiety arising from apprehension and suspicion from community members, distress and possible use of demographic details for marketing purposes. The following measures were put in place to ensure that should these risks occur, the impact will be minimised significantly. These include ensuring transparency, strict confidentiality of information and anonymity of participants in the study and counselling of participants who will part take in the study.

3.5.1.4 Community Entry

The study commenced with reconnaissance visits in February 2018, May 2018 and January 2019. The purpose of these visits was to acquaint the researcher with the study area and observe at first hand, what the issues were as far as cultural ecosystem services and coastal flooding were concerned. These visits were also to afford the opportunity to establish relationships with key persons within the district assemblies of the study area for secondary information and also meet the assembly members within whose electoral areas the communities are located.

3.5.1.5 Questionnaire Pre-Testing

On 27th and 28th January of 2018, the questionnaires were pre-tested after which the questionnaires were modified to reflect the objectives of the study. Based on the pre-testing some of the questions were reframed. Fifteen households were involved in the pretesting. Different versions of the questionnaires were formulated to elicit appropriate responses. This process enabled the researcher to appreciate how respondents understood the questions in order to correct long and repetitious questions. Some of the questions were shortened and reworded to make them more specific.

3.5.1.6 Household Survey

From the 5th of March to the 14th of March 2018, questionnaires were administered in the seven (7) coastal communities along the coast of Ada - Wokumagbe, Akplabanya, Anyamam, Lolonya, Totope, Azizanya/Kewunor and Azizakpe (Island Community). An additional 10% of the sample was added to the sample of 350 to make provision for errors arising from spoilage and mistakes. Therefore, in all, a total of 385 questionnaires were administered with the assistance of four field assistants.

3.5.1.7 Key Informant Interviews

In addition to the household survey, key informant interviews were also conducted with the Chiefs, Assemblymen and Opinion Leaders of the seven communities. Some of these Opinion leaders included the Linguist of Wokumagbe, the former assembly member of Anyamam, the Unit Committee Secretary for Anyamam, and the Assembly Member for Goi who takes care of Anyamam because the Assembly Member of Anyamam is deceased. The Palace Secretary for the Lolonya Chief, the Community Relations Officer for Ada East and the District Planning Office for Ada West were interviewed. Twenty key informants interviewed were held in the two districts. The table below (table 2) shows the key informants in the various communities and their gender.

Table 2: Key Informants

No	Key Informants	Gender
1	Linguist of Wokumagbe	Male

No	Key Informants	Gender
2	Assembly member for Wokumagbe	Male
3	Former Assembly member for Akplabanya	Male
4	Assembly member for Goi	Male
5	Unit Committee Secretary for Anyamam	Male
6	Place Secretary for Lolonya	Male
7	Chief of Lolonya	Male
8	Chief of Anyaman	Male
9	Community relations officer of Ada East	Female
10	District planning officer Ada East	Male
11	District planning officer Ada West	Male
12	Opinion leader of Totope	Male
13	Chief of Totope's Wife	Female
14	Assembly member of Lolonya	Male
15	Chief Fisherman of Akplabanya	Male
16	Prominent fishmonger	Female
17	Chief of Azizanya/Kewunor	Male

No	Key Informants	Gender
18	Chief of Azizakpe	Male
19	Opinion leader of Azizanya/Kewunor	Male
20	Key Informant at District Assembly (Ada West)	Male

The table 2 above shows that there were seventeen males and three female key informants in the study.

3.5.1.8 Expert Interviews

In addition, interviews with institutional heads were conducted. Eleven institutional heads were interviewed. The institutions included NADMO (in both districts), Wildlife Division of the Forestry Commission, The District Health Directorate, The District Education Directorate, the Volta River Authority, Environmental Health Officers, Planning Officers. All the institutional heads were males. Table 3 below shows the various institutional heads and their gender. In all, out eleven institutional heads comprising three (3) females and eight (8) males were interviewed.

Table 3: Institutional Heads

No	Institutional Heads	Gender
1	NADMO Ada East	Male
2	Department of Wildlife	Male
3	Ghana Health Service	Female
4	Ghana Education Service	Male

5	Volta River	Male
6	Community Relations Officer (Ada East)	Female
7	Environmental Protection Agency	Female
8	District Planning Officer (Ada West)	Male
9	Greater Accra Regional NADMO	Male
10	Physical and Planning Depts (Ada East)	Male
11	Physical and Planning Depts (Ada West)	Male

3.5.1.9 Focus Group Interviews

Focus Group Interviews involve individuals or people with similar characteristics who focus discussions on a particular subject matter (Dilshad & Latif, 2013) . The membership of the group is usually between six and nine who are moderated by a trained researcher or facilitator to explore attitudes, perceptions, ideas and feeling about a particular issue. Focus group interviews are characterised by three main factors (G. Anderson & Arsenault, 2005). Firstly, there must be an important prompt, trigger or stimulus that is initiated by the researcher or moderator. Secondly, focus group interviews emphasise on the moderator being neutral. Lastly, interaction among the members of the group is considered important rather than being considered as a mere conversation. Six focus group discussions were held. Focus group interview aims at collecting high quality data in social context and with the viewpoint of the participants been the main focus. The groups included Fishermen in Akplabanya who also constituted men groups, Fishmongers in Akplabanya, sections of women in Azizanya, Chiefs, and elders of Anyamam and sections of women in Azizakpe. These groups were interviewed separately at different times.

3.5.1.10 Observation

Observation as a tool for data collection was used to understand the phenomenon under study. Observation has been a useful tool for both anthropological and social enquiry (Kawulick, 2005) and it is a systematic description of events, behaviour and artefacts in a study setting. It enables the researcher to describe the situation under study with the five senses. Observation provides a holistic understanding of the phenomenon in an accurate and objective way given the limitation of the study. Observation also enhances the validity of the study as better understanding of the problem is achieved (DeWalt & DeWalt, 2002). The study at first hand observed the impact of erosion in the communities and the devastation caused by floods, degraded ecosystems and cultural benefits that are associated with them. Photographs of these were taken and most of them became the basis for further discussions with some of the key informant interviews.

3.5.2 **Secondary Data**

Secondary data was collected from relevant institution such as the Ada East and Ada West District Assembly, the Ghana Statistical Service (GSS), National Disaster Management Organisation (NADMO) and the Wildlife Division of the Forestry Commission for the study. Other sources of data included journal articles, newspapers and web pages. Secondary data was also collected from repositories such as WXTide.

3.6 Data Analyses

Various methods of data analyses (qualitative, quantitative and GIS) were used in the study based in the objectives set out. The following sections describe the data analyses methods.

3.6.1 Analysis of Drivers of Flooding

Primary data was analysed using quantitative and qualitative methods. Quantitative analysis software packages i.e. SPSS and STATA were used for descriptive statistics (frequency tables, pie charts etc) of the perception of drivers of flooding among community members, and for confirmatory analyses of the relationship between perception of drivers of coastal flooding and meteorological data from secondary sources such as Ghana Meteorological Agency. NVIVO software and content analyses were used to analyse the qualitative data to explore in further detail the emerging themes in cultural ecosystem service status and impact. Climatic indicators were selected based on Wong et al., (2014). Confirmatory analysis was done using structural equation modelling to validate the perception of drivers of flooding among local people. Shoreline measurements were also taken to confirm the extent of erosion reported by local people.

3.6.1.1 Structural Equation Modelling

The process for developing the structural equation model is based on the steps recommended by Lei & Wu (2007). This includes model specification involving conceptualisation of the model presented graphically; review of data characteristics to determine sample size required and types of variables; identify parameters and estimate variables by achieving convergence; and finally, evaluate the success of the model taking into account the errors and model fitness of the data.

In structural equation model, the parameter is the value of interest, which might be a regression coefficient between the exogenous and the endogenous variable or the factor loading (regression coefficient between an indicator and its factor).

The models are givens as;

$$Flooding = b_0 + b_1 Geomorphic + b_2 Anthropogenic + b_3 climate + \varepsilon$$

$$Place = b_0 + b_1 Flooding + \varepsilon$$

$$Cultural\ livelihood = b_0 + b_1 Flooding + \varepsilon$$

$$Recreation = b_0 + b_1 Flooding + \varepsilon$$

$$Aesthetic = b_0 + b_1 Flooding + \varepsilon$$

Equation 2: Structural Equation Model Equation

where b_0 is constant and b_i is the coefficients of the exogenous variables and ε is the residual or the error margins.

The variables used in the structural equation model are

I. Latent, endogenous variables
   - flooding

II. Observed, endogenous variables
   - Place
   - Cultural livelihood
   - Recreation and
   - Aesthetics

III. Latent, exogenous variables

- Anthropogenic
- Climate
- flooding

IV. Observed, exogenous variables

- Sand winning
- Land Use
- Vegetation
- Siltation of welt
- Industrial Activities
- Encroaching Development
- Encroaching Development
- Dam spillage
- Lack of drainage
- Sea level rise
- Tidal waves
- Rainfall
- Geomorphic

3.6.1.2 Shoreline Measurements and Erosion Rate Determination

Digital Shoreline Analysis Software (DSAS), an extension of ArcGIS, was used to analyse and interpret shoreline positions and movements for the period March 1985, January 1999, November 2007 and February 2017. DSAS was used because of its ability to compute the rate of change statistics and the user-friendly graphical interface (Oyedotun, 2014). Satellite imagery (Landsat 4-5 TM C1 Level 1 for 1985 and 1999 images and 7 ETM+ C1 Level 1 for 2007 and 2017) was downloaded at 30-meter resolution from the United Stated Geological Survey sites. The time frame used for data collection and analysis was due to the quality of satellite image beyond this period. With the aid of the remote sensing tool ENVI, version 5.3, anomalies in the downloaded images such as cloud cover and grid lines and clarity were corrected by pre-processing the images through gap fill processing, radiometric and geometric corrections to ensure accuracy. To do this, a baseline was created offshore because the objective of the study is to observe the movement of the shoreline towards the land or the extent of erosion rather than accretion. Shorelines positions for 1985, 1999, 2007 and 2017 were digitized and transect from the baseline were cast across the digitized lines such that the intervals of shoreline movements could be computed. To ensure accuracy in the average rate of change the interval between transects was set at 50 meters. The End Point Rate (EPR) and Net Shoreline Movement (NSM) were computed and used to determine the historic rate of shoreline. The DSAS was used to calculate the shoreline because it has the advantage of considering uncertainties due to position and measurement errors. The positioning errors can be due to factors that are related to phenomena that can affect the precision of the analysis because for a given year the actual position could be different from what is determined. Some of the sources of errors arise from digitisation while others can be caused by tides and waves.

3.6.1.3 Estimation of Shoreline Rate of Change Uncertainties

In the estimation of errors of shoreline rates calculation along the Ada coast, three sources of errors were used. The errors are image processing, digitisation and georeferencing errors. Calculation of the uncertainties in the erosion rates was obtained using the root-mean-square error technique recommended by (Fenster et al., 1993). The estimate of uncertainty for each transect was calculated. The digitization error was determined based on the recommendation by Jayappa et al, (2014) who suggested that mapping errors can be estimated as +/- 10-meters for the pre-2000 data and +/-5m for post-2000 data. Estimated error for image processing was based on Landsat resolution errors estimated at ±30-meter and georeferencing error based on Nassar et al., (2018). Nassar used +/-4.9, +/-4.7, +/-3.5, +/-1.7 for 1989, 1998, 2010 and 2016 respectively. These error rates were adopted because that dates are around the same period.

The square root of the addition of uncertainties for each shoreline position squared determines the uncertain at a given year. This is represented in equation 2;

$$E_a = \pm\sqrt{Ed^2 + Ep^2 + Eg^2}$$

Equation 2: Error equation for a particular year

E_a represents total uncertainty for the year; Ed represents error from digitization; Ep represents error from image processing; and Eg represents error from georeferencing.

Total uncertainties for the period was also obtained using the formulae shown in equation 3 which is represented as;

$$Total\ Error = \pm\frac{\sqrt{E_1^2 + E_2^2} + E_3^2 + E_4^2}{T}$$

Equation 3: Error estimation for the total period

E_1 is uncertainty for 1985; E_2 is uncertainty for year 1999; E_3 is uncertainty for 2007 and E_4 is uncertainty for 2017. T is the total time elapsed from 1985 to 2017. The value of error for each year is squared and the mean of the square root is calculated by dividing over total time elapsed. Total error obtained was ±3.9m/yr (table 4).

Table 4: Determination of error of shoreline datasets

Estimated error shoreline datasets

Estimated errors	**1985**	**1999**	**2007**	**2017**
Digitization error (*E_d*)	±10	±10	±5	±5
Image processing error (*E_p*)	±30	±30	±30	±30
Georeferencing error (*E_g*)	±4.9	±4.7	±3.5	±1.7
Total error (*E_t*)	32.00	31.97	30.61	30.46
Annualised error for 32yrs (*E_a*)	3.9 m/yr			
The uncertainty of end point rate calculation (ECI) (m/year)	1985-1999	1999-2007	2007-2017	1985-2017
	2.29	4.00	3.83	0.95

RMSE (root mean square error)

While the total error obtained from the calculation is high, Morton, Miller and Moore (2004) have argued that the effects of positional error on long term data are reduced (32 years in this study). This is especially so considering that data availability for images in the 1970s and 1980s are limited or inadequate.

3.6.1.4 Land Cover Change Detection and Assessment

For the vegetation change analysis, Landsat images of the study area were downloaded for the periods 1985, 1999, 2007 and 2017. Images with high resolution were obtained. This required the use of images during the dry season i.e. (December-April) because likelihood of cloud interference is low. A subset of the research area was clipped using the Area of Interest (AOI) that was created in ERDAS Imagine (2014). The images were processed using the ERDAS 2014 to layer stack the images and classification. Four classifications were used in the study because they were the main land use types that were identified during fieldwork (i) dense vegetation, (ii) grassland vegetation, (iii) water and (iv) urbanised or built up areas. These classes were evaluated to determine the extent to which they contribute to flooding.

3.6.2 Analysis of Status of Ecosystem and Cultural Ecosystem Services

Quantitative and qualitative methods were used to analyse the drivers of flooding, status of ecosystems and their impact on cultural ecosystem services. Descriptive statistics such as frequency tables, graphs and charts were also used to analyse ecosystem types and cultural ecosystems services that have been lost. The variables were ranked on a scale of 1 to 5 to determine the extent to which respondents considered them important and analysed using SPSS (where 1 is not important at all and 5 in extremely important). Again, confirmatory analysis was conducted to establish the relationship between flooding and cultural ecosystem services. Other variables were assessed using qualitative tools such as focus group discussions and key informant interviews. The qualitative data was analysed using NVIVO software to code responses into themes and analyse them thematically.

3.6.2.1 Cultural Ecosystem Health Assessment Framework

Ecosystem health is a term used in environmental management, development discourse and academia. It refers to the condition of the environment or a state of the environment that is desirable relative to a set of anthropogenic, ecological and economic processes and their relationship with measures of sustainability and the ability of the system to withstand interference. Ecosystem health assessment has been going on in the scientific community for decades originating with river health indices like the biotic integrity (Karr, 1989).

In human terms, health is defined as the absence of disease or symptoms of disease. In the practice of Medicine however, generally, it is upon screening for a particular disease that one can assess health status in relation to that disease. The standard is applied in ecosystem health assessment. For this study, a framework was put together as a basis of Cultural ecosystem status assessment. These indicators were selected based on variables that were determined by various authors as shown in table 5 below.

Table 5: The Framework for the Determination of Cultural Ecosystem Status

Sense of Place (Stedman, 2003)	**Aesthetic CES indicators (Tveit & Fry, 2006)**	**Recreational CES Indicators (Ward and Snelder 1997)**	**Cultural livelihood**
Physical Environment	Change in vegetation in beach landscape (WHO,	Impact of shoreline fluctuation on recreation	Domestic activities
Erosion	Beach landscape	Sea level effect on recreation	Occupational fulfilment
Place Attachment	Urbanisation (Morgan 1999)	Wave climate on use of beach	Tradition and Custom
	Historical Richness (Morgan 1999)	Beach Littering	Sense of belonging

	Beach Landscape (WHO,	Beach profile	Apprehension about the future
		Beach accessibility	

Sense of Place as an indicator for cultural ecosystem services was based on Steadman (2003), who argue that physical characteristics of place has a significant role to play in attachment. Ethics value of a place is also based on a set of indicators that is succinctly defined by (Ghana Statistical Service, 2014). The indicators for recreation were selected from landscape character assessment framework by Ward & Snelder (1997). Cultural livelihood is measured by five variables, i.e., (i) domestic activities which include daily routines, (ii) sense of belonging, (iii) apprehension towards the future, (iv) occupational fulfilment and (v) tradition and customs. These indicators were ranked on a scale of Very Low, Low, Medium, and High. Very low in this context is extreme deterioration while very high is signifies that the cultural service is still functioning as it has been.

3.6.3 Development of Bayesian network model for cultural ecosystem service management in Ada

The development of the Bayesian network model for coastal flood management in Ada was based on Düspohl et al., (2012) and Chan et al., (2010). It involved seven steps which are problem definition, variable selection, interim network development with stakeholders, design and construction of conditional probability tables based on assigned weights, review of model and testing and evaluation and recommendation. The steps are shown in figure 4 below.

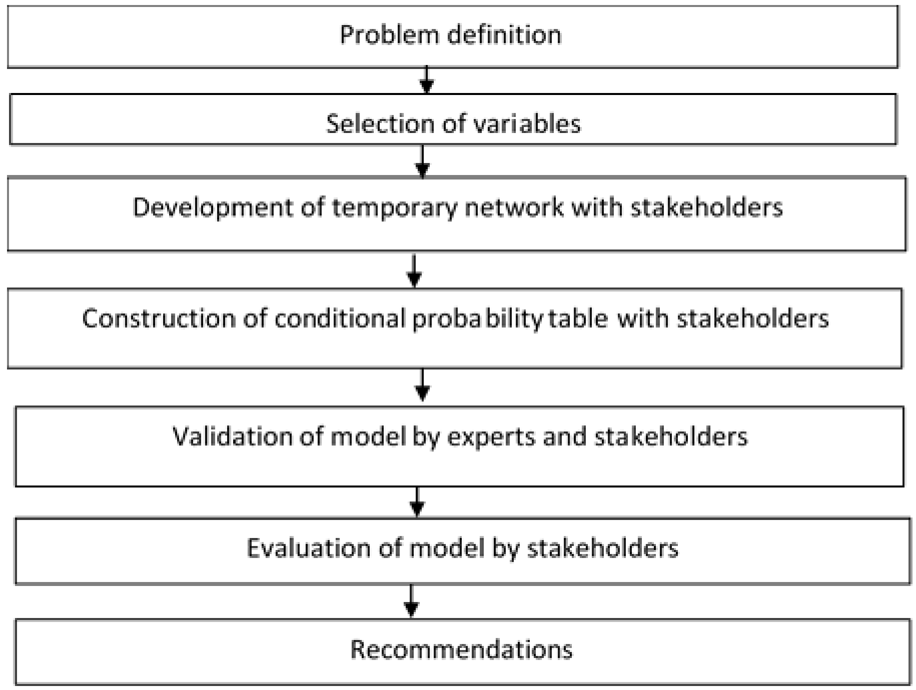

Figure 4: Bayesian modelling steps

Figure 4 shows the model approach that was used in the study. Detailed description of each step of the process has been described below.

To analyse the extent to which the Bayesian Network model can be used as decision support tool, Netica version 6.03 was used. While noting that there are several software for building probability models such as Hugin (Konis, 2011), GeNie (Bayes Fusion LLC, 2019) and Analytica (Lumina Decision Systems Inc, 2015). The choice of the Netica was because among other attributes it is able to compile belief (Bayesian) networks into junction trees of cliques for fast probabilistic reasoning and has an optimizing compiler to generate good junction trees. It can also assess probabilistic relations from data and generate presentation quality graphics which can be transferred to other documents (Norsys Software Corporation, 1997).

3.6.3.1 Problem Definition for the Bayesian Model

For this study, the problem was to understand the future implications of coastal flooding in cultural ecosystems services. The problem formulation also involved field interviews with traditional authorities, technocrats at the district assembles in Ada, expert interviews and household interviews to ascertain cultural ecosystems that are available in Ada and how these are impacted by coastal flooding. It also involved the review of literature to understand the conceptual underpinning of the drivers of coastal flooding and how these impact cultural ecosystem services. To ensure that the process was participatory, focus group discussions were held with various groups i.e. men, women, fishermen, fish mongers and traditional authority.

3.6.3.2 Variable Selection

After defining the problem, the variables were selected based on Wong et al., (2014) framework for main climate related drivers for coastal systems, their trends and their main physical ecosystem effect which were validated from field results. The anthropogenic drivers were adapted from the same source and revised based on field data. Cultural ecosystems services variables for the framework were also selected from Gould & Kekuewa (2017). Based on field results, 'cultural livelihood', which is not in the established typologies for ecosystem services, was introduced as a new variable and added to the cultural ecosystem service indicators (table 6).

Table 6: Description of Bayesian Model Variables

Variable	Description
Wave	Average Monthly waves height (m)
Tide	Average monthly tidal level (m)
Rainfall	Average Monthly rainfall (mm)

Variable	Description
Erosion	End point rate (m)
Sand winning	Based on expert assessment
Population	Annual population growth rate
Flooding	Frequency of flood events
Place	Erosion rates
Aesthetics	Value judgement based on landscape attributes
Recreation	Pleasure people derive from natural ecosystems
Slope	slope is the rise or fall of the land surface
Topography	The physical features of the area

A preliminary framework was designed to explore the linkages among the variables under consideration. This initial framework was carefully reviewed based on availability of historical data and extent to which various drivers contributed to flooding (figure 5).

3.6.3.3 Model Development

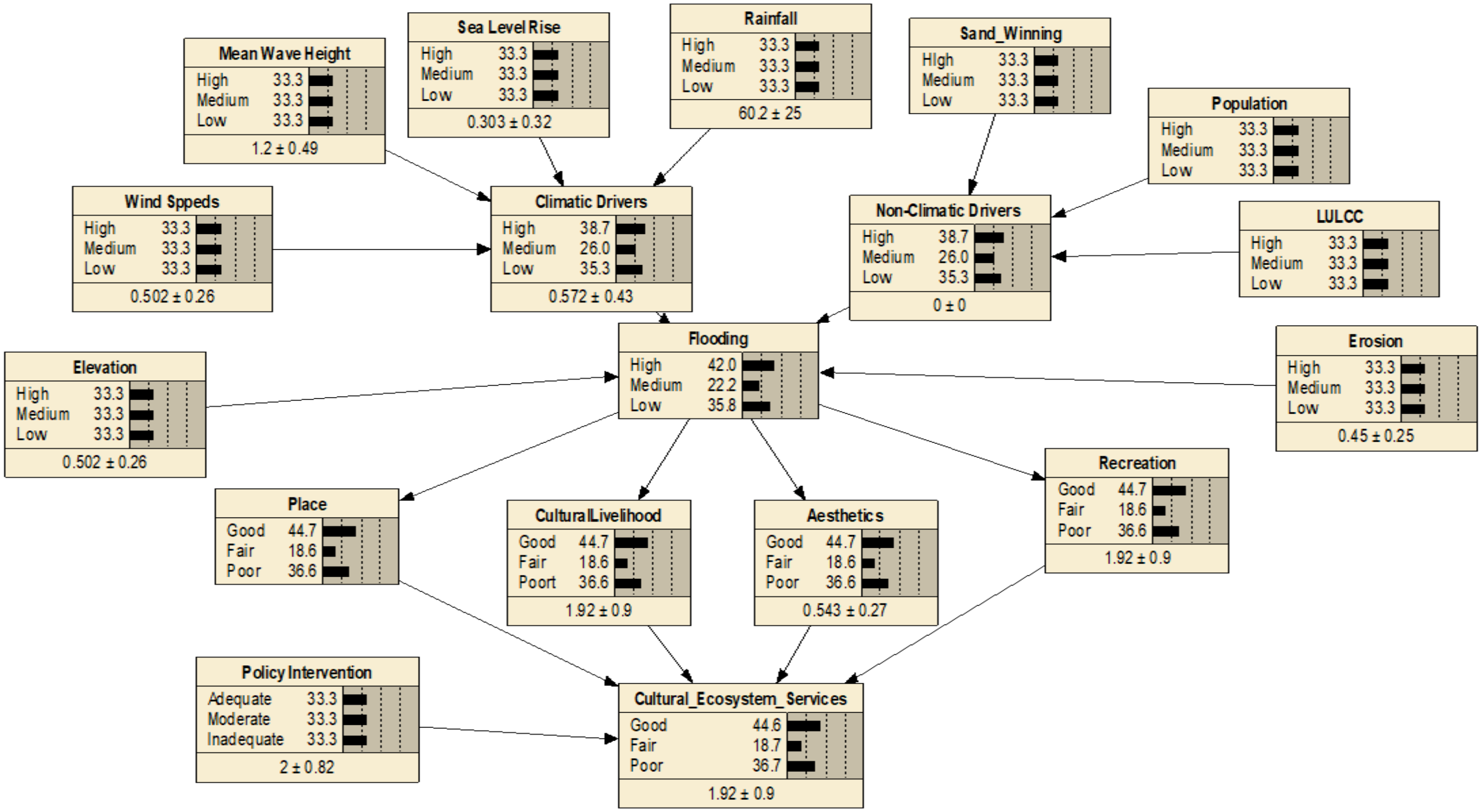

Figure 5: Model Framework for Management of Cultural Ecosystems Services developed from Netica version 6.03

3.6.3.4 Stakeholder Involvement in Model Development

Stakeholder involvement in the model development started from the beginning of fieldwork where various key stakeholders such officers at the wildlife, NADMO and the district assemblies were interacted with to understand the phenomenon of coastal flooding in Ada. To validate the perspectives of the key stakeholders, further engagements were held with community members through focus group discussions to understand the various dimensions to the problem of flooding and its relationship with cultural ecosystem services. Based on discussions with community members, the perspectives of key informants in terms of the variables that drive flooding. Climatic drivers of flooding based on Wong et al. (2014) were also discussed with key informants. These discussions with stakeholders informed the development of the pro-type model.

3.6.3.5 Construction of Conditional Probability Table

Based on the initial framework for the model, the conditional probability table was developed. Experts assigned weights to the various drivers based on their expertise. To validate the assigned weights to the variables, they were compared with historical data to assess trends and significance of their contribution to flooding. This ensured that variables that had recorded stable trends were assigned medium weights while variables that have deteriorated or worsened were assigned higher weights. Variables with low levels of deterioration were assigned lower weights (table 7).

Table 7: Variables and their states in CES Management in Ada Bayesian networks

Variable	States in CES Management
Sea Level rise	0≤1.3≥
Wave	Low (0,1,2), Medium (3,4,5), High (6,8,9) (World Meteorological Organisation Sea State Codes)
Tide	0≤0.95≥
Rainfall	0≤10.31≥
Erosion	End Point Rate
Sand winning	Low (0,1,2), Medium (3,4,5), High (6,8,9)
Population	Low (0,1,2), Medium (3,4,5), High (6,8,9)
Flooding	Low (0,1,2), Medium (3,4,5), High (6,8,9)
Place	Shoreline Erosion
Aesthetics	Landscape beauty and litters
Recreation	Relaxation and enjoyment
Elevation	Low (0,1,2), Medium (3,4,5), High (6,8,9)

3.6.3.6 Model Evaluation

The model was reviewed to validate the choice of variables and weights and recommendations were incorporated into the model. At this stage, as recommended by Henriksen et al., (2007), the model was tested and the pitfalls were identified and recommended. The review of the model process was based on the ability of the model to deal with complex planning, integration of knowledge from diverse sources and its ability to link research to policy (Henriksen et al., 2007).

3.6.3.7 Empirical Data Basis for Model Development

There were two sources of empirical data for the development of the model. Empirical historical data and household data for 358 households were collected. In addition, group discussions and expert interviews were also collected. Historical rainfall and wind data were collected from the Ghana Meteorological Agency spanning 32 years. The trends in the data were observed and the averages calculated to form the basis of rainfall variable state. Historical shoreline estimates were also calculated to establish the magnitude of erosion. Hind cast Wave and Tide data were also obtained from WXTide and Marine and Fisheries Sciences Department of the University of Ghana. Elevation data was also obtained from the United States Geological Survey (USGS) website.

Data on population, as one of the anthropogenic drivers, was obtained from the Ghana Statistical Service (GSS). Land use and vegetation change was observed from the periods under study i.e. 1985, 1999, 2007 and 2017 using remote sensing and GIS. These empirical data sources formed the basis for assignment of weight for the various variable indicators and formed the basis for scenario analysis. Apart from the empirical sources, expert views or judgement was also obtained to validate the empirical data. The combination of these formed the basis of assignment of weights to the variables for the model.

Based the empirical data and expert judgement, weights were assigned to the climatic drivers of flooding on a scale of 0-1 (table 8).

Table 8: CPT for Climatic Drivers

Wave	**Sea level**	**Wind Speed**	**Rainfall**	**Sum=1**
0.3	0.1	0.3	0.3	

Wave, rainfall and wind speed were assigned weights of 0.3 based on data and periods of flooding which is consistent with what expert judgement. Sea level rise was assigned a weight of 0.1 because sea level rises over time.

The weights assigned to anthropogenic drivers of flooding which are sand mining, urbanisation and vegetation change are 0.45, 0.35 and 0.2 respectively. These were also based on data analysis and expert judgement. The weights are show in table 9 below.

Table 9: CPT for Anthropogenic Drivers

Sand Winning	**Population**	**LULCC**	**Sum=1**
0.45	0.35	0.2	

Cultural ecosystem indicators were also assigned weights that formed the basis of model. The following table (table 10) shows the weights that were assigned to cultural ecosystems with various probable policy intervention scenarios that were applied to the model.

Table 10: CPT for Cultural Ecosystem Service

Aesthetics	**Place**	**Recreation**	**Policy Intervention**	**Cultural Livelihood**	**Sum=1**
0.15	0.35	0.15	0.25	0.1	

CHAPTER FOUR

4. Results

4.1 Introduction

This chapter presents findings from the study based on its three main objectives. Firstly, the chapter presents findings for the first objective to identify the drivers of flooding and analyses of the extent to which the drivers account for flooding. It also compares the perception of flooding with remotely sensed data and other measurements such as sea level rise, wind speeds and wave heights and erosion rates to validate the perceptions of the respondents. Secondly the chapter presents the cultural ecosystems that were identified and their status due to the impact of flooding. Finally, this chapter presents results on the application of Bayesian model as a decision support tool to manage the future implication of coastal flooding on cultural ecosystems services.

4.2 Socio-Demographic Characteristics of Respondents

The characteristics of the respondents who participated in the study are presented in table 11. The mean age of the respondents is 51.21. The largest age group was between 40-49 years constituting 25.1%. Eighty-three percent of the respondents were married and the remaining 13% of the respondents were separated, divorced, single or widowed. Seventy-five percent of the respondents were men, reflecting the patriarchal characteristic of the communities. A significant percentage of the respondents had no education (38.3%). Primary occupation in the area is fishing followed by trading and the others. Forty-eight percent of the respondents were household heads and had farming as their primary occupation. Household heads who were traders represented 15.9%. It is important to note that almost all the respondents had multiple sources of income for the household from primary and secondary occupations. Decisions on the use of household income are made by the household heads who are mostly male.

Table 11: Demographic profile of respondents

Variable **Age**	**Frequency (N=358)**	**Percentage (%)**
20-29	17	4.7
30-39	65	18.2
40-49	90	25.1
50-59	84	23.5
60-69	59	16.5
70 and Above	43	12.0
Marital Status		
Married	299	83.5
Separated	13	3.6
Divorced	4	1.1
Single	6	1.7
Widow	33	9.2
Widower	3	0.8
Gender		
Male	268	74.9
Female	90	25.1
Education		
No Education	137	38.3
Primary	65	18.2

Variable **Age**	**Frequency (N=358)**	**Percentage (%)**
JHS	98	27.4
Vocational	6	1.7
SHS	43	12.0
Polytechnic	1	0.3
University	6	1.7
Other	2	0.6
Occupation		
Farmer	22	6.1
Fisherman	172	48.0
Trader	57	15.9
Unemployed	12	3.4
Government Worker	21	5.9
Artisan	24	6.7
Salt Mining	5	1.4
Fish Monger	24	6.7
Other	21	5.9
Religion		
Christian	324	90.0
Islamic or Moslem	2	1.0
Traditionalist	24	7.0
Others	8	2.0
Ethnicity		
Dangme	323	90.2

Variable Age	Frequency (N=358)	Percentage (%)
Ewe	33	9.2
Others	2	0.6

Seventy-eight-point two percent of the household heads owned lands of various sizes. Lands were either acquired by household head or inherited from family, father or a relative. Decisions regarding the use of lands are normally taken collectively by the extended family. The size of owned land ranged from 0.25 acres to 37.5 acres. The mean size of land-owned is 4.64.

Ninety percent of the respondents were Christians while 7% of them were traditionalist. Only 1% of the respondents were Muslims while the remaining 2% belonged to no religion.

4.3 Perception of Flooding

Flooding is a prevalent predicament in Ada and affects both people and the ability of ecosystems to deliver services. Ninety-eight percent of respondents have experienced flooding within the study communities (Table 10).

4.3.1 Flood Experience, Types and Frequency

Three main types of floods were identified by respondents in Ada (Table 10). These are coastal floods, pluvial floods and riverine floods. Majority (49.9%) of the respondents experienced coastal floods caused by the seawater which inundates the shores and land. This is followed by 40.6% of respondents who experienced Pluvial floods usually caused by surface runoff during heavy rainfall. Riverine flood was experienced by 9.5% of the respondents when the Volta River overflows its banks.

Another form of riverine flood that was identified is experienced almost daily and results from the interaction between high tides from the sea and the river. It is mostly experienced by those communities who live along the banks of the river i.e. Azizanya, Azizakpe and Kewunor.

At high tides in the morning, the river floods the community, recedes from late morning and then recurs mid-afternoon. This type of riverine flood was observed to be intertidal (inter-tidal floods)". Inter-tidal flooding recurs every 24 hours as a result of one full rotation of the Earth around its own axis. The extent of the flood depends on how high the tide is. Table 12 shows the percentage of people who have experienced flood. It shows that the issue of flooding is widespread among communities and the need to understand how it impacts people and cultural ecosystem services is imperative. Most (98%) of the residents of communities have experienced flooding. Only 2% of the respondents have not experienced flooding.

Table 12: Flood experience and types of flooding in Ada

No	**Types of Floods**	**Percent**
1	Coastal Floods	49.9
2	Pluvial	40.6
3	Riverine Floods	9.5

Flooding is a very frequent phenomenon experienced by communities in Ada (table 13). Thirty-five-point eight percent of the respondents considered flooding to be very frequent i.e. about five times per annum while 27.4% considered it to be quite frequent at about three times per year flooding to be three times per year. In total about 63.2% of the surveyed population considered flooding to be frequent at different scales.

Table 13: Frequency of flooding in Ada

Frequency of flooding in Ada	**Frequency**	**Percent**
Not Frequent	64	17.9
Somewhat Frequent	32	8.9
Not Sure	36	10.1
Quite Frequent	98	27.4
Very Frequent	128	35.8
Total	358	100.0

According to the majority (46.6%) of respondents, severe flooding occurs about twice a year. This is followed by those who responded that flooding occurs about 3-5 times in a year (37.2%). Sixteen-point two percent of the respondents experienced flooding about 6-10 times a year. The variation in the frequency of flooding is influenced by the location of the residents (table14).

The frequency of flood occurrence is also depicted in table 14 below with a majority (46.6%) of the respondents indicating that flooding occurs between one 1-2 times annually.

Table 14: Frequency of flooding

Flood Occurrence	Frequency	Percent
1-2	167	46.6
3-5	133	37.2
6-10	58	16.2
Total	358	100.0

Table 15 below shows the town and the type of responses that are attributed to the cause of flooding and type. Most (72.7%) of the residents of Azizanya and Kewunor reported riverine flooding as the dominant type of flooding in the community. Residents of Akplabanya,Anyamam and Totope communities which are close to the sea considered coastal flooding as the dominant type of flooding recording 92%, 96.9% and 93.3% respectively. Residents of Wokumagbe indicated runoff as the dominant flood type recording 78.6%.

Table 15: location of flooding and type of flood experienced

No	Type of flood	Name of Towns						
		Wokumagbe	**Akplabanya**	**Anyamam**	**Lolonya**	**Azizanya/Kewunor**	**Azizakpe**	**Totope**
1	Riverine or Fluvial Flooding	42.9%	32.0%	15.3%	4.4%	72.7%	66.7%	40.0%
2	Surface Run-off or Pluvial Flooding	78.6%	74.0%	65.3%	75.6%	69.1%	33.3%	60.0%
3	Coastal flooding	42.9%	92.0%	96.9%	88.9%	54.5%	91.7%	93.3%

4.4 Periods of flooding

According to respondents, flooding is mostly experienced between May and July and normally around September and October. Respondents said the patterns are changing in recent times and this makes it difficult to be precise with periods. Some were of the view that flooding now occurs anytime.

4.5 Notice of Flooding and Assistance during flooding

During flooding events, residents are assisted by various institutions within the districts. Most of the assistance comes from the National Disaster Management Organisation (90.5%), with remaining from the district assembly, office of the member of parliament of the area or help from other sources such are relatives and neighbours (table 16).

Table 16: Assistance during flooding

Source of Assistance	Frequency	Percent
NADMO	324	90.5
District Assembly	16	4.5
MP	2	0.6
Community Members	2	0.6
Others	14	3.9
Total	358	100.0

The majority of respondents are unaware about impending flooding events, as 82.7 % indicated that they do not receive prior information (figure 6).

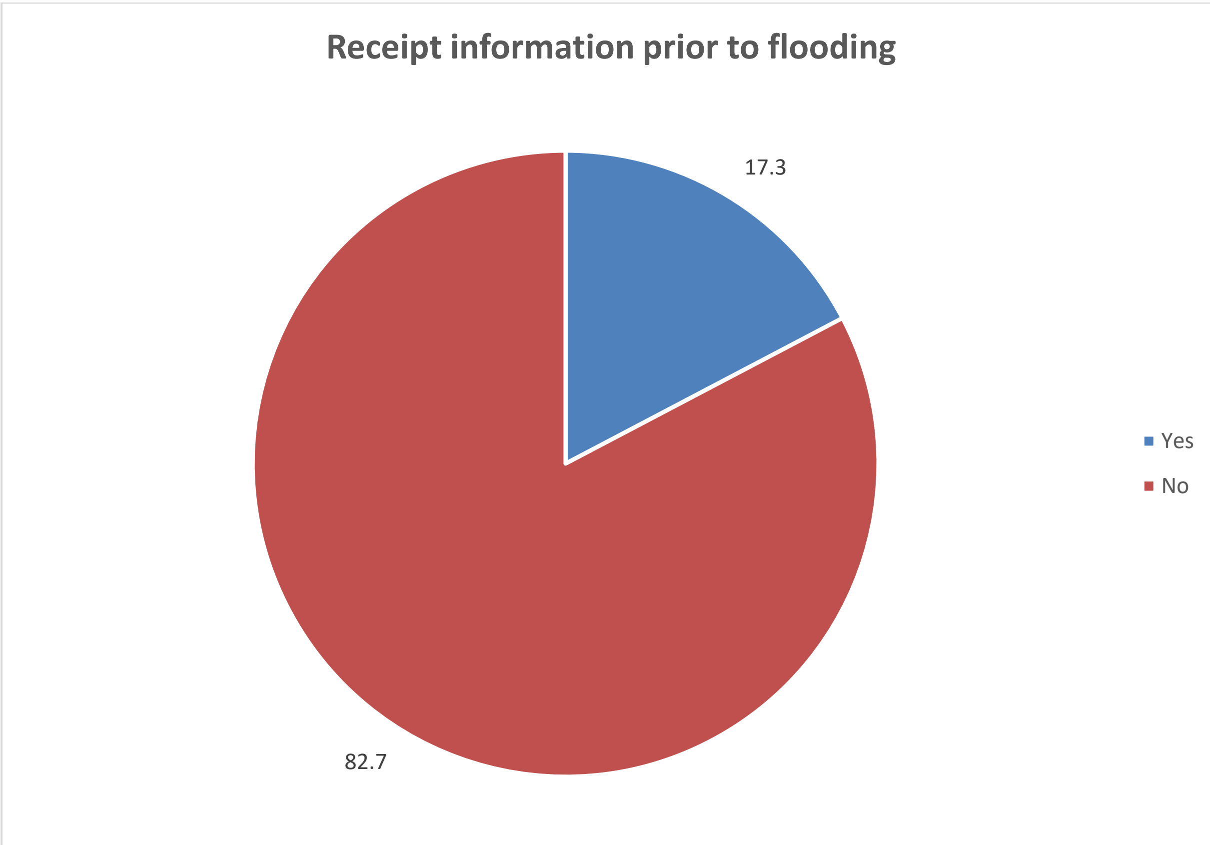

Figure 6: Receipt of warning of flooding events

Of the 17.3% of the respondents who indicated receiving warning before flooding, 85.5% of them received such warning through radio while 9% receive the notice through the meteorological department on television. A minority (2.2%) of the respondents receive the warning through community information system and about 2.3% of the community members receive information from other sources such neighbours and friends as shown below (figure 7).

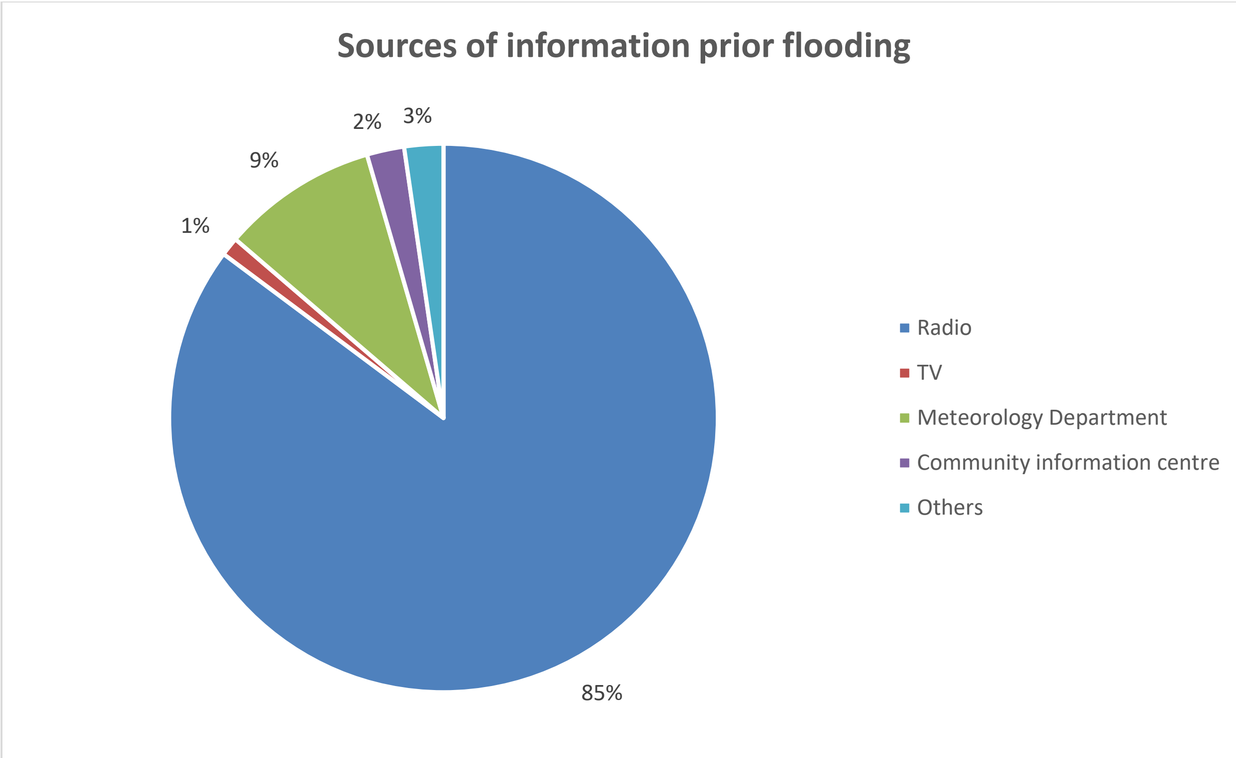

Figure 7: Sources of flooding prior to flooding

4.6 Response to Flooding

At the household level people construct barriers to prevent water from the getting into the homes. While these barriers get inundated during heavy floods, they can reduce the flow of water into their homes during high tides. Figure 8 shows examples of the methods residents use to prevent floods from entering their homes.

Figure 8: Household response to flooding in Ada. Source: Fieldwork, 2019

Others migrate from their homes when flooding becomes very severe. Figure 9 below shows a house that has been abandoned as the occupants migrate to a different location.

Figure 9: Lost Place; occupants have migrated. Source: Fieldwork, 2019

4.7 Perceived Drivers of Coastal Flooding in Ada

Proximate causes of flooding and underlying drivers of flooding were identified by respondents in the study area (table 17). In all, 13 proximate causes and underlying drivers were identified as the main causes of flooding in the seven communities. The most perceived causes of flooding are the rise in sea level (24%), surface run-off (19.5%) and storm surge (17.2%).

Table 17: Drivers of flooding

No	**Drivers of Flooding in Ada**	**Percentage**
1	Sea level rise	24.0%
2	Surface Run-off	19.5%
3	Storm surge	17.2%
4	River	13.7%
5	Sand Mining	5.5%
6	Erosion	4.9%
7	Siltation of Wetland	4.3%
8	Encroaching development	3.7%
9	Urbanization	2.2%
10	Salt Mining Activity	2.1%
11	Vegetation change	1.5%
12	Dam Spillage	1.2%
13	Lack of Drainage	0.2%

Principal component analysis identified three main categories of drivers of flooding in Ada (table 18). Four components were extracted from the thirteen drivers of flooding in Ada. Out of the four components, only three of them were significant contributors to flooding due to their factor loading. These are components 1,2 and 3. The three main components of flood drivers are climatic or weather-related drivers, non-climatic drivers and geomorphic. The non-climatic drivers are made up of two classes which are anthropogenic and geomorphic. Anthropogenic drivers result from human activities such as sand winning, urbanisation etc. Geomorphic drivers are associated with the geomorphological conditions of the area such as elevation and geology. Table 19 below shows the components or categories of drivers of floods.

Table 18: Results of Principal Component Analysis

Drivers of Flood	Component			
	1	2	3	4
Urbanisation	0.779			
Vegetation	0.746			
Erosion	0.686			-0.483
Siltation of Wetlands	0.579			
Sand Mining	0.578			-0.47
Harbour Development	0.548			
River	0.467			
Dam Spill		-0.76		
Lack of drains		-0.759		
Storm surge		0.541	0.444	
Surface Run-off		0.411		
Sea Level Rise			0.808	
Salt Production Activities				0.579

Table 19: Categories of Driver of flooding based on principal component analysis

Categories of Drivers of Coastal Flooding	
Climatic	Non-Climatic

	Anthropogenic	Geomorphic
Surface run-off	Sand Mining	Geology
Sea Level Rise	Siltation of wetlands	Erosion
Storm Surge	Urbanisation	Silting of river bed
Riverine	Salt Production Activities	
	Dam Spillage	
	Harbour Developments	
	Lack of drains	

4.8 Relationship between perceived drivers and flooding

The relationship among the various perceived drivers of the flooding and the extent to which they account for flooding were carried out using structural equation model analysis (figure 10). The results show that about 84% of flooding is accounted for by climatic, non-climatic and geomorphic factors with residuals of 0.42, 0.64 and 1.00, respectively. A high co-efficient of 4.0 obtained from the analysis shows that climatic factors are dominant drivers of flooding in Ada. This is followed by geomorphic factors with a coefficient of 2.6 and anthropogenic driver coefficient of 1.7. The contribution of human activities to flooding is minimal. The P value obtained for the various categories of drivers of flooding also showed the extent to which flooding is affected by the categories.

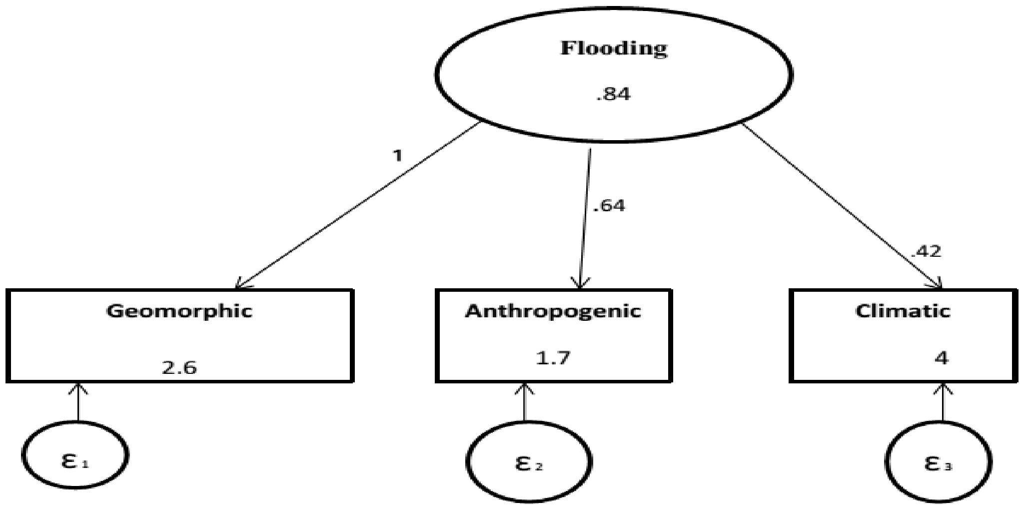

Figure 10: Structural model of the relationship between flooding and the various drivers.

4.8.1 Confirmatory Analysis of Anthropogenic Drivers of Flooding

All the coefficient of the variables such as sand winning, land use, vegetation, siltation of welt, salt mining activities, encroachment development, dam spillage and lack of drainage measurements were significant showing a significant path relationship to the latent variable *Anthropogenic*. Moreover, Schumacker & Lomax (2004) recommend that the values of Root Mean Square Error of Approximation (RMSEA) below 0.05 is considered significant and the RMSEA for anthropogenic is 0.000. Hence the model satisfactorily fits the data. (Rajendran et al., 2017). Hu & Bentler (1998) recommended that values of CFI and TLI must exceed 0.95 for the path to be considered as significant. The result in Table (20) shows that all the variables under Anthropogenic are jointly significant $(CFI = 1.000; TLI = 1.013)$. Table 20 below shows the confirmatory analysis for the anthropogenic drivers of flooding.

Table 20**:** Confirmatory Analysis of Anthropogenic Drivers of Flooding

Variables	Coefficient	Std. Err.	z-value	p-value	RMSEA	CFI	TLI
Sand winning	1.00	(constrained)					
Constant	2.39	0.09	27.78	0.00	**0.000**	**1.000**	**1.013**
Land Use	1.40	0.20	6.99	0.00			
Constant	2.13	0.07	28.92	0.00			
Vegetation Cover	1.37	0.20	6.71	0.00			
Constant	1.74	0.06	27.95	0.00			
Siltation of welt	0.86	0.17	5.17	0.00			
Constant	2.34	0.08	28.17	0.00			
Salt mining Activities	0.38	0.12	3.22	0.00			
Constant	1.73	0.07	25.59	0.00			
Encroaching Development	0.96	0.17	5.71	0.00			
Constant	2.08	0.08	27.07	0.00			
Dam spillage	0.31	0.12	2.61	0.01			
Constant	0.78	0.06	12.36	0.00			
Lack of drainage	0.51	0.11	4.57	0.00			
Constant	0.64	0.05	12.85	0.00			

4.8.2 **Confirmatory Analysis of Climatic Drivers of Flooding**

All the coefficients of the variables such as sea level rise, tidal waves and rainfall measures of climate were significant showing a significant path relationship to the latent variable *Climate*. All the variables under *Climate* are jointly significant (table 21), based on RMSE of 0.000, *CFI=0.9635; TLI = 1.004* (Schumacker & Lomax, 2004; Hu and Bentler,1999)

Table 21: confirmatory analysis of climatic drivers of flooding

Variables	Coefficient	Std. Err.	z-value	p-value	RMSEA	CFI	TLI
Sea level rise	1.00	(constrained)			**0.000**	**0.9635**	**1.004**
Constant	3.99	0.08	51.73	0.00			
Tidal waves	1.03	0.01	83.55	0.00			
Constant	3.96	0.08	49.90	0.00			

Rainfall	0.98	0.02	64.64	0.00
Constant	4.01	0.08	52.23	0.00

4.8.3 Confirmatory Analysis of Flooding

All the coefficients of the variables geomorphic, anthropogenic and climate measuring flooding were significant, showing a significant path relationship to the latent variable *Flooding*. The result in table 22 shows that all the variables under *Flooding* are jointly significant ($CFI = 1.000; TLI = 1.013$).

Table 22: Effects of Geomorphic, Anthropogenic and Climate on Flooding.

Variables	Coefficient	Std. Err.	z-value	p-value	RMSEA	CFI	TLI
Geomorphic	1.00	(constrained)			**0.022**	**0.986**	**0.998**
Constant	2.60	0.08	31.21	0.00			
Anthropogenic	0.64	0.20	3.21	0.00			
Constant	1.73	0.04	45.50	0.00			
Climate	0.42	0.11	3.97	0.00			
Constant	3.99	0.08	51.87	0.00			

4.9 Comparison of Perceptions and Measured Drivers of Flooding

The perception of the drivers of flooding in Ada is compared to time series data from measurements and analyses of the following remotely sensed data analysed with geographic information systems.

4.9.1 Sea Level Rise

Climatic drivers of flooding identified include sea level rise, storm surge and run-off. These climatic drivers of the coastal floods are consistent with Wong's classification (Wong, 2014). During certain periods, these individual events occur simultaneously and cause excessive damage to property and livelihoods in the communities. Modelled data obtained from WXtide between

1985 and 2017 shows that sea level has been rising at an average rate of 0.03 meters per annum over the 32-year period (Figure 11).

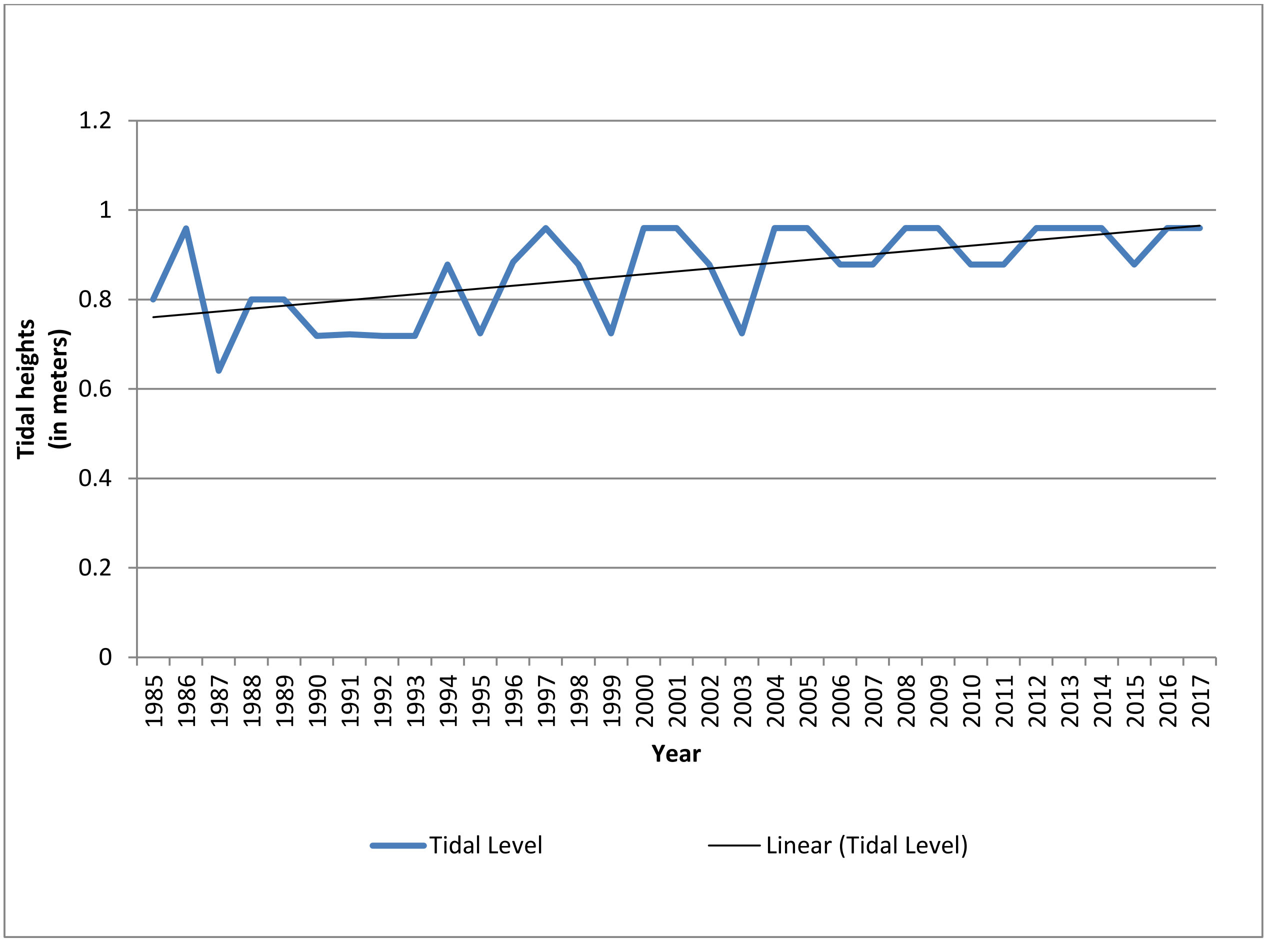

Figure 11: Trend of sea level rise from 1985 to 2017 (Source: WXTide)

The positive linear relationship between the tidal level and the year over of the period correlates with the perception of the respondents. In spite of the increasing annual trends in tide level, data shows that there are two peak in the year (in May and October) where the tides are relatively higher and cause flooding in Ada (figure 12).

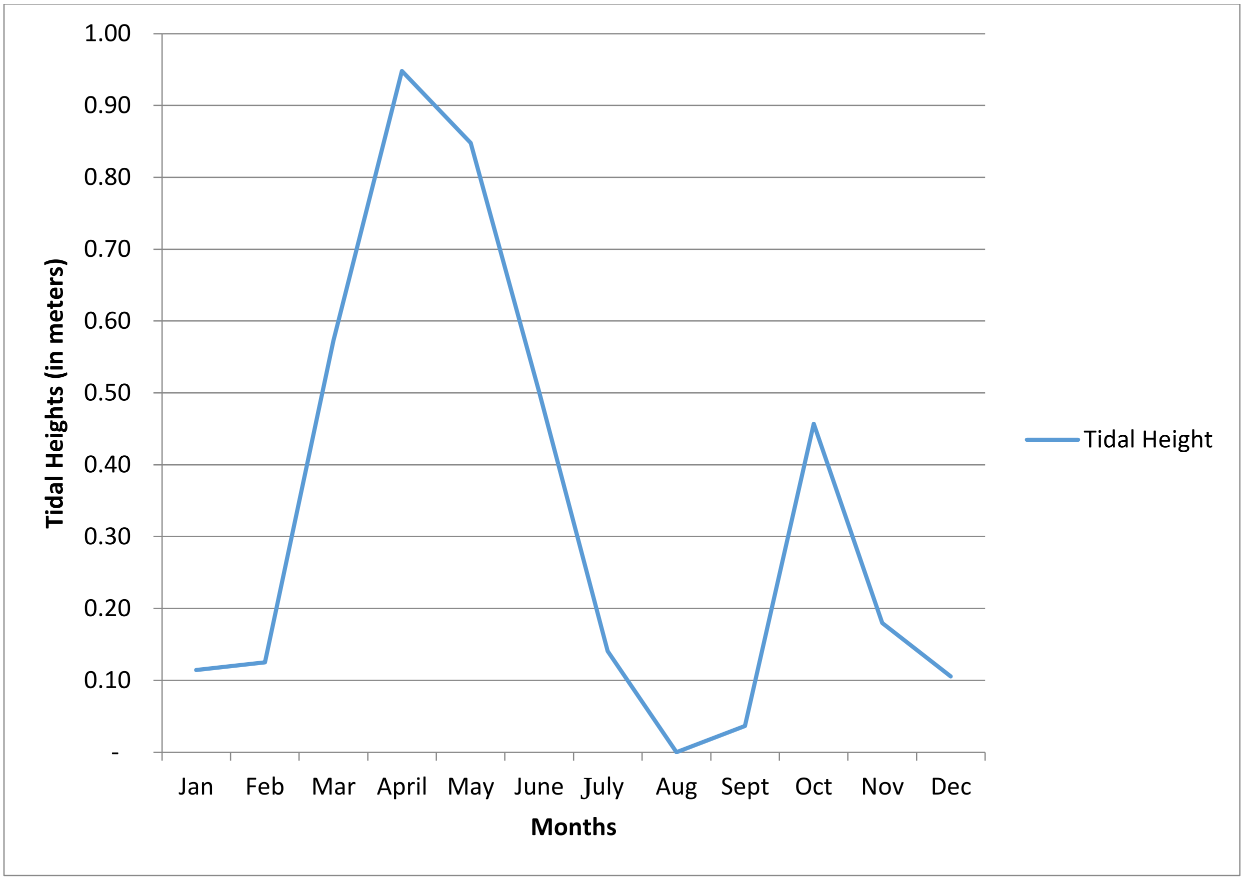

Figure 12: Periods of high tides in Ada

4.9.2 **Storm Surge**

Storm surge is driven by two principal factors; wave and wind climate. Evidence from modelled data obtained from WXTide National Oceanic and Atmospheric Administration (1982) shows that wave climate trend from 1985 to 2017 has been high. The interaction of the general wave climate and the wind climatic which are normally high within the periods May, June and July combine to cause storm surge which leads to flooding. Flooding also occurs because around the period tidal levels are also high. The conditions that give rise to flooding are also the same around the September and October albeit at a lower scale.

Figure 13 below represents wave heights from 1985 to 2017. Wave heights sometimes rise as high as 2.8 meters above the average of 1.5 meters. Wave activities are high in Ada.

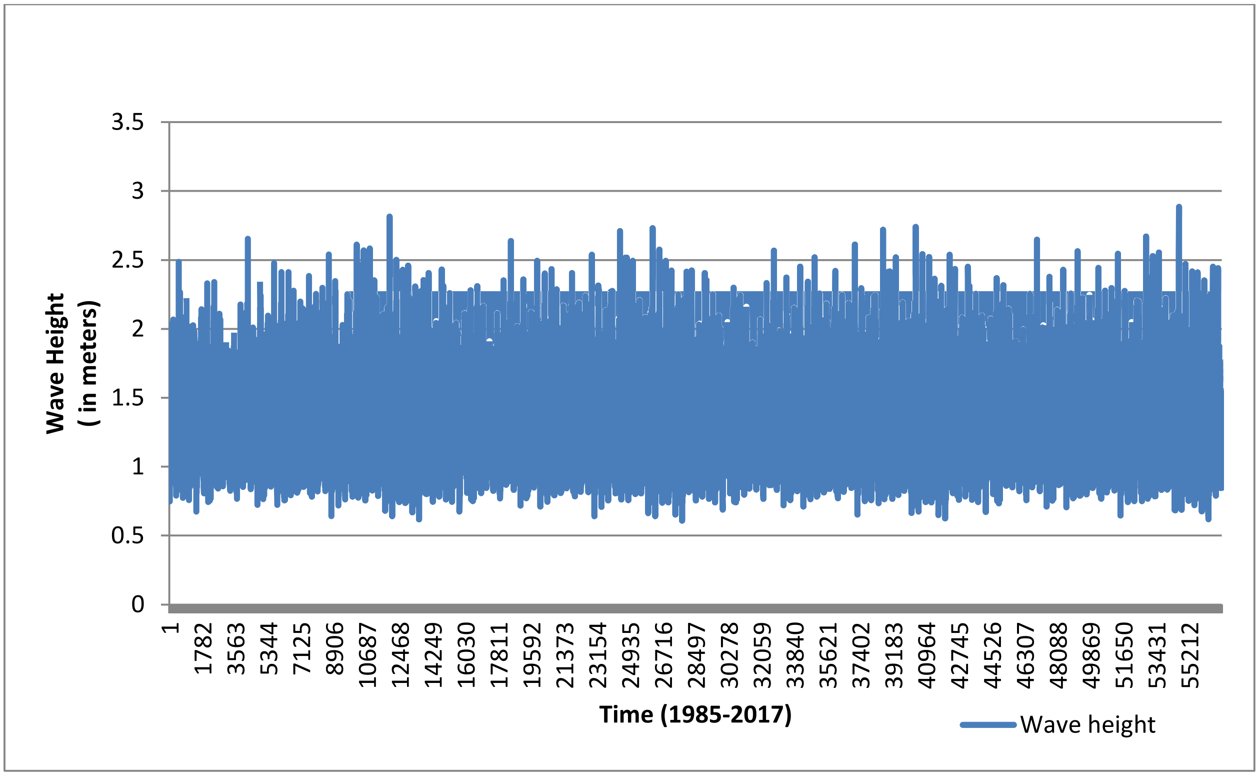

Figure 13: Trends of wave heights from 1985-2017 (Source: WXTide)

The trends of wind climate also show that there has been a general intensity of wind speeds and these are more severe in specific periods of the year. Wind speeds are normally high around May, June and July. It can be deduced that high waves coupled with abnormal wind speeds around May and June increases the likelihood of storm surge and therefore coastal floods. The trend line figure 14 depicts an increasing rate in the wind speeds.

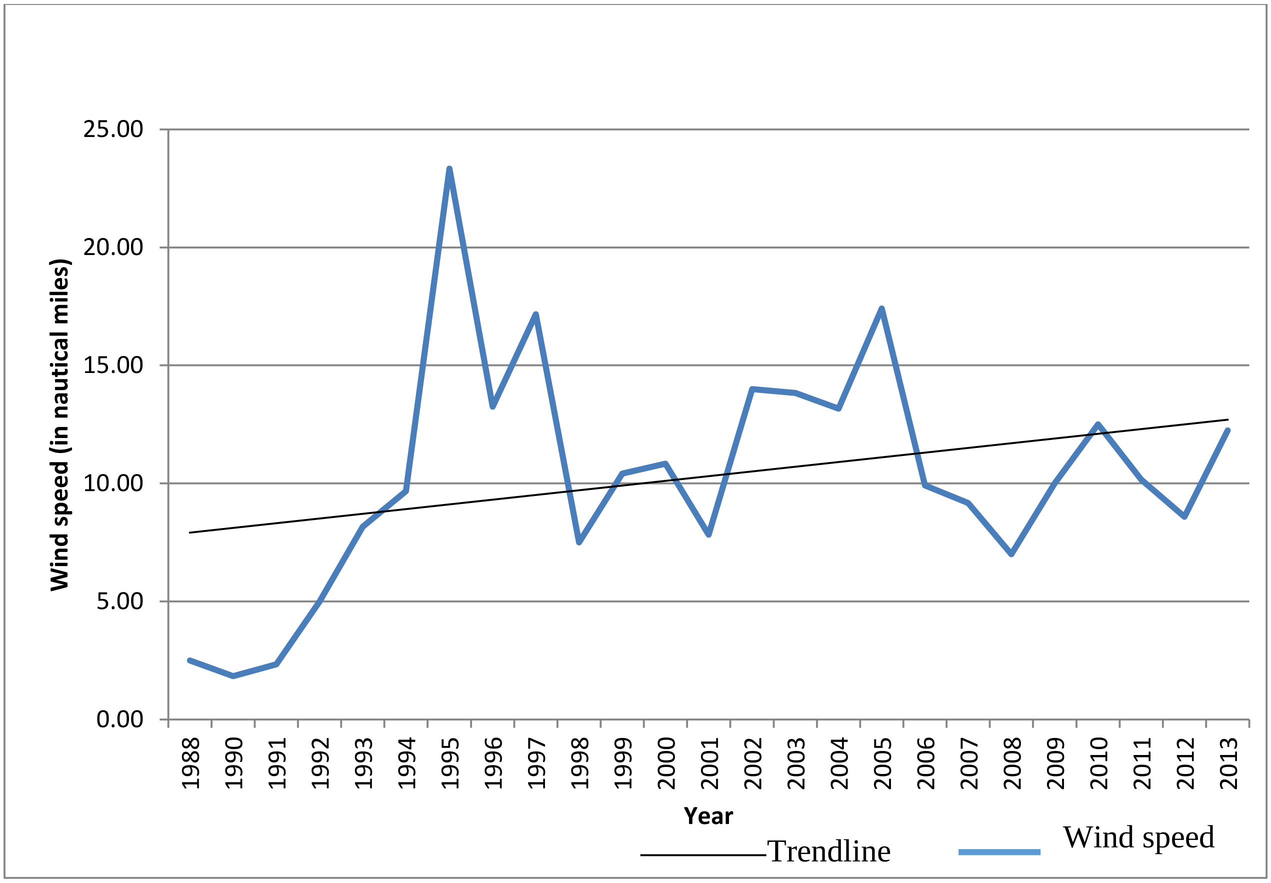

Figure 14: Average annual wind speeds from 1985 to 2013. (Source: Ghana Meteorological Agency, Accra)

4.9.3 Rainfall

Rainfall patterns from 1985 to 2017 have not changed much. Ada continues to experience major and minor rainfall patterns which are typical throughout the country. The major rainfall season occurs around May, June and July and the minor season that occurs around September and October. Average monthly rainfall can increase to about 200 millilitres in June and about 75 millilitres in October. The rainfall pattern is shown in figure 15 below.

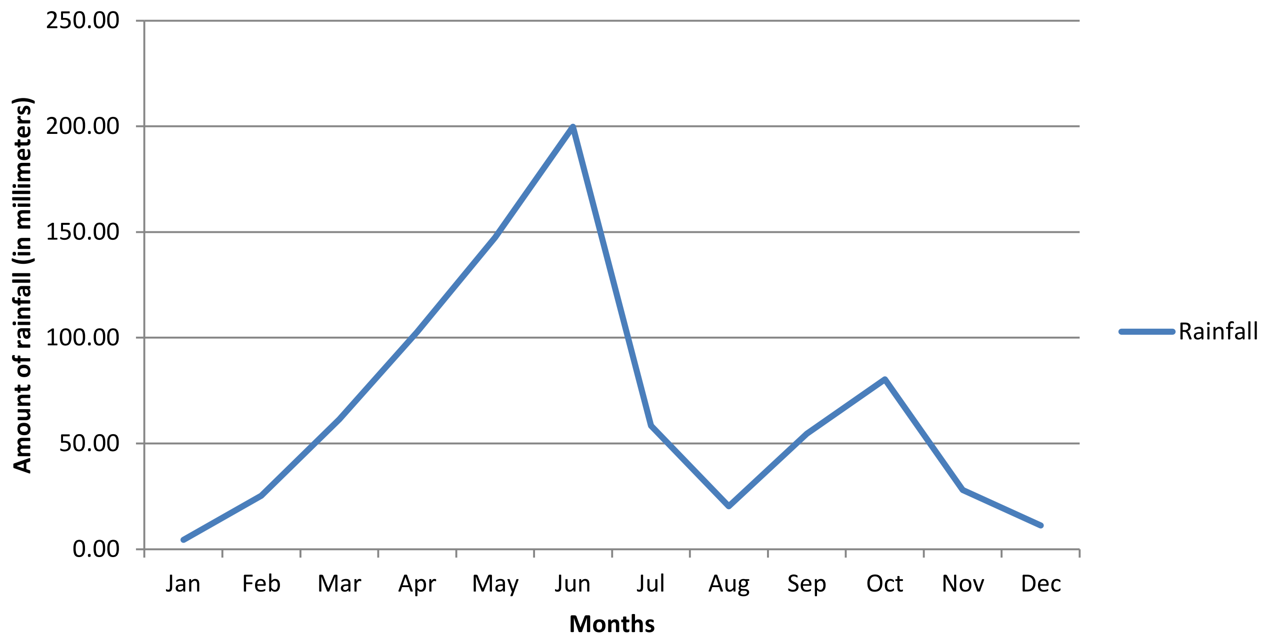

Figure 15: Average monthly wind speed (Source: Ghana Meteorological Agency, Accra)

Figure 15 shows that the main rainfall season peaks around June and the minor season is around October. Generally, however, the pattern shows that the main rainfall season in Ghana is between April and July. There is a minor season around September and October.

Figure 16 below shows the rainfall pattern from 1985 to 2017. Between the periods of 1985 to 2017, the trends in rainfall have been relatively stable showing stability with significant average annual variations. Average monthly rainfall between April and June is 150 millimetres. This period has the highest rainfall and it is considered the major rainy season. There is a minor rainy season that occurs between September and October.

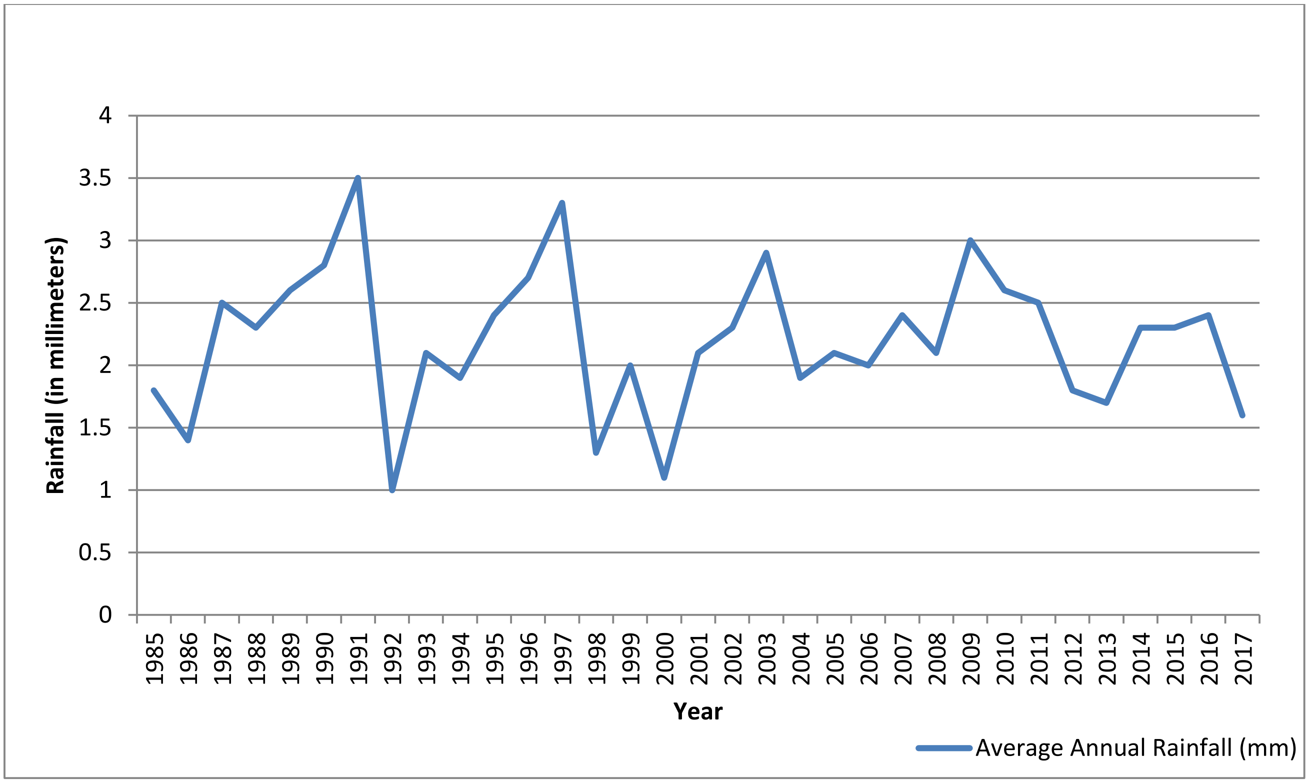

Figure 16: Average annual rainfall from 1985 to 2017 (Source: Ghana Meteorological Agency, Accra)

A total of 349 respondents representing 97.5% indicated that rain floods occur during the rainy period and about 82.7 % also indicated rain induced floods are very high during this period. The response was consistent with secondary data obtained from the Ghana Meteorological Agency. During this period coastal, riverine and rain floods are experienced in almost all the communities since rain water has to run-off. People along the channel of flow get affected by the river.

4.9.4 **Flooding as causes of Erosion**

Results from the shoreline analysis shows that overall shoreline is eroding at an average rate of 3.84 meters per year and that there is no accretion occurring along the coast from Azizanya to

Wokumagbe. Erosion rate are as high as -10 m and as low as -7 m. There was no accretion at any of the transects. Figure 17 shows shoreline positions and transects which were used to measure shoreline change. Results show that there has been erosion of -3.84m along the coast of Ada between 1985 and 2017. The coastline shifts closer to people's homes and a slight increase in tides, waves and wind speed leads to flooding of these places.

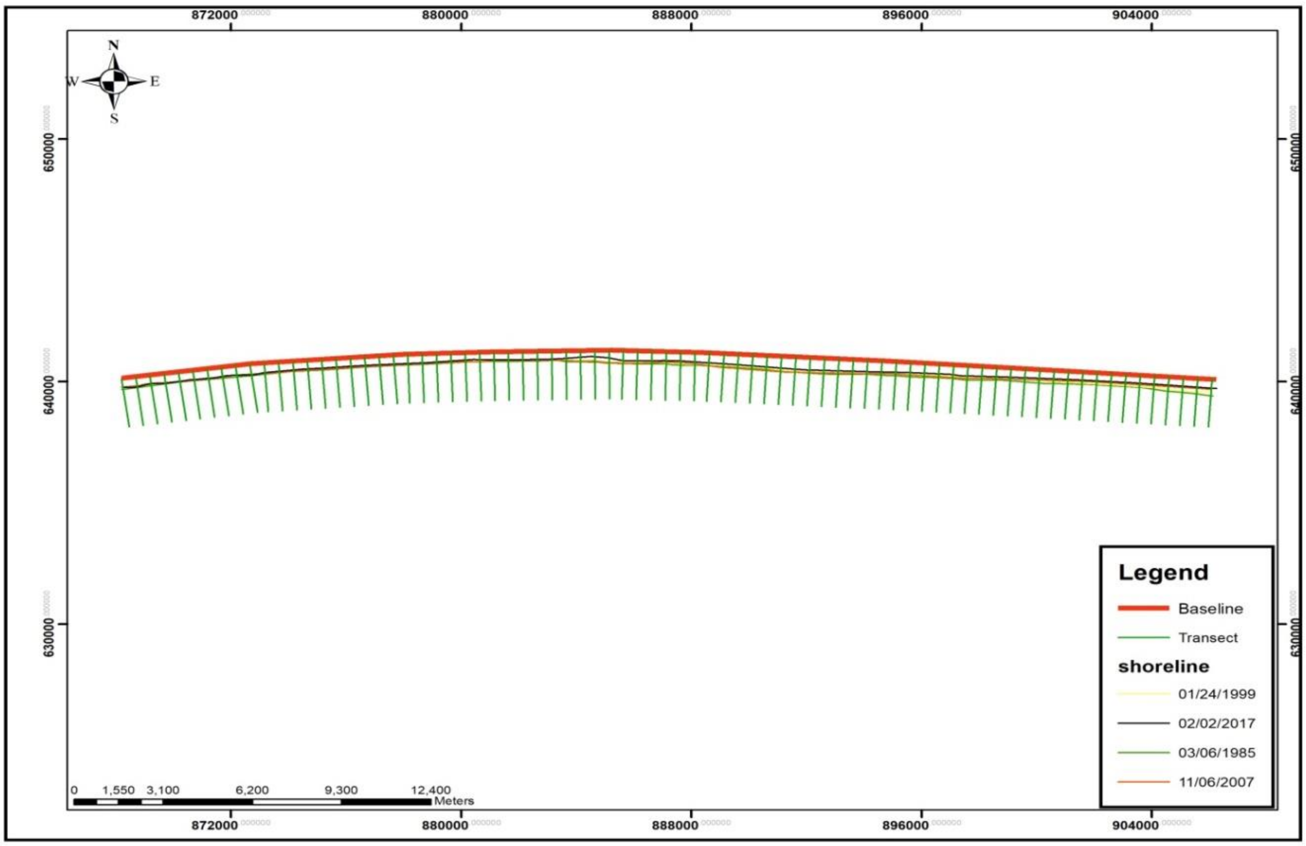

Figure 17: Erosion along the coast of Ada

The picture below (Figure 18) shows erosion is also causing vegetation loss along river banks. Over the 32-year period under study a significant amount of coconut vegetation has been lost due to erosion of shoreline. The second picture shows an eroded house where the occupants have been forced to move from their home.

Figure 18: Shows the extent to devastation caused by flooding in Ada.

The rates of erosion at various transects has also been presented figure 19. The graph represents erosion rates at transects along the coast of Ada. The area around the estuary has experience more erosion than the area to the west of Ada.

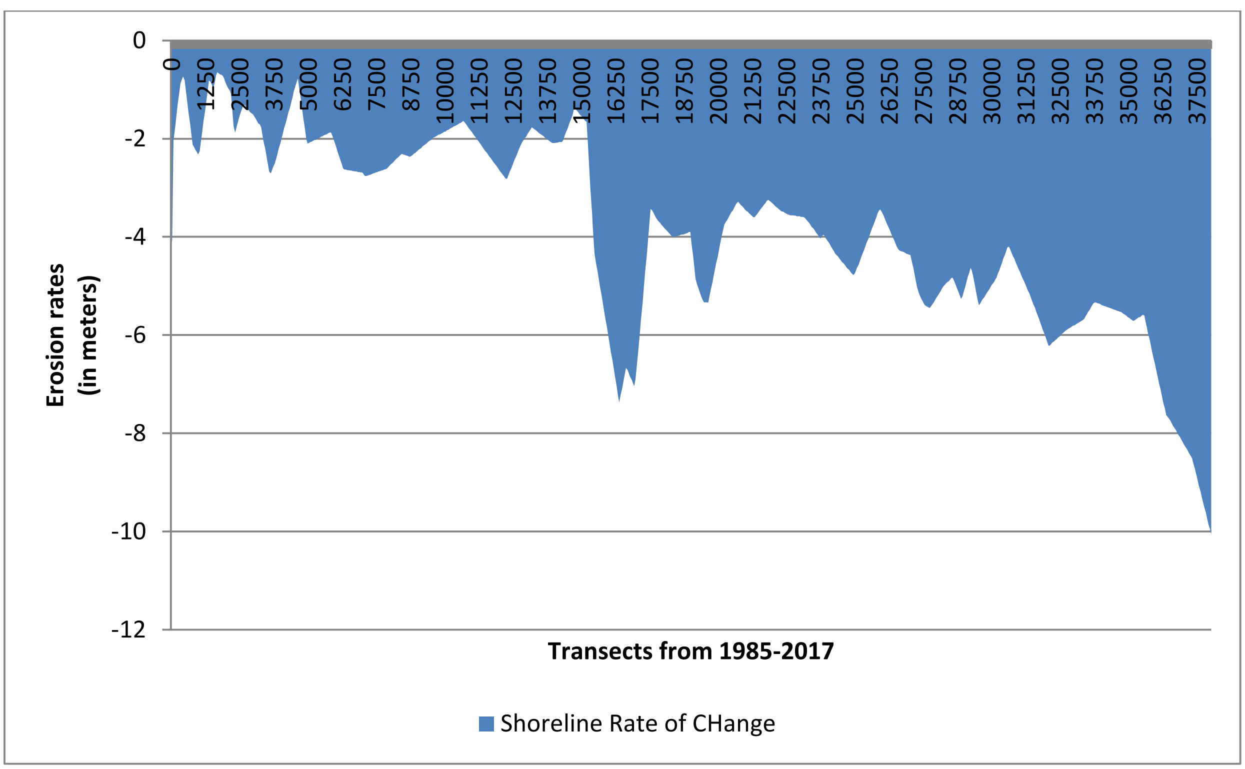

Figure 19: Trends of erosion in Ada from 1985 – 2017

Figure 19 shows that the area to the right which is around Wokumagbe has experienced a significant amount of erosion. This is evident from that fact that Totope, Anyamam towards Wokumagbe have experienced significant erosion.

4.10 Non-Climatic Drivers

Non-climatic or anthropogenic factors were also found to contribute significantly to flooding in Ada. Some of the non-climatic factors contributing to flooding include Sanding winning, industrial activities, land use and disturbance of the Songhor lagoon system. The following sections outline in detail how these factors contribute to flooding.

4.10.1 Urbanisation

Urbanisation is a significant driver of flooding in Ada. The principal driver of urbanisation in Ada is population which has been growing at an annual rate of about 2.6% based on data from Ghana Statistical Service (GSS, 2012).

Figure 20 above shows the population of Ada from 1985 to 2017. The selected years are based on the period used in determining the shoreline changes. This is to ensure consistency and make analysis more cogent.

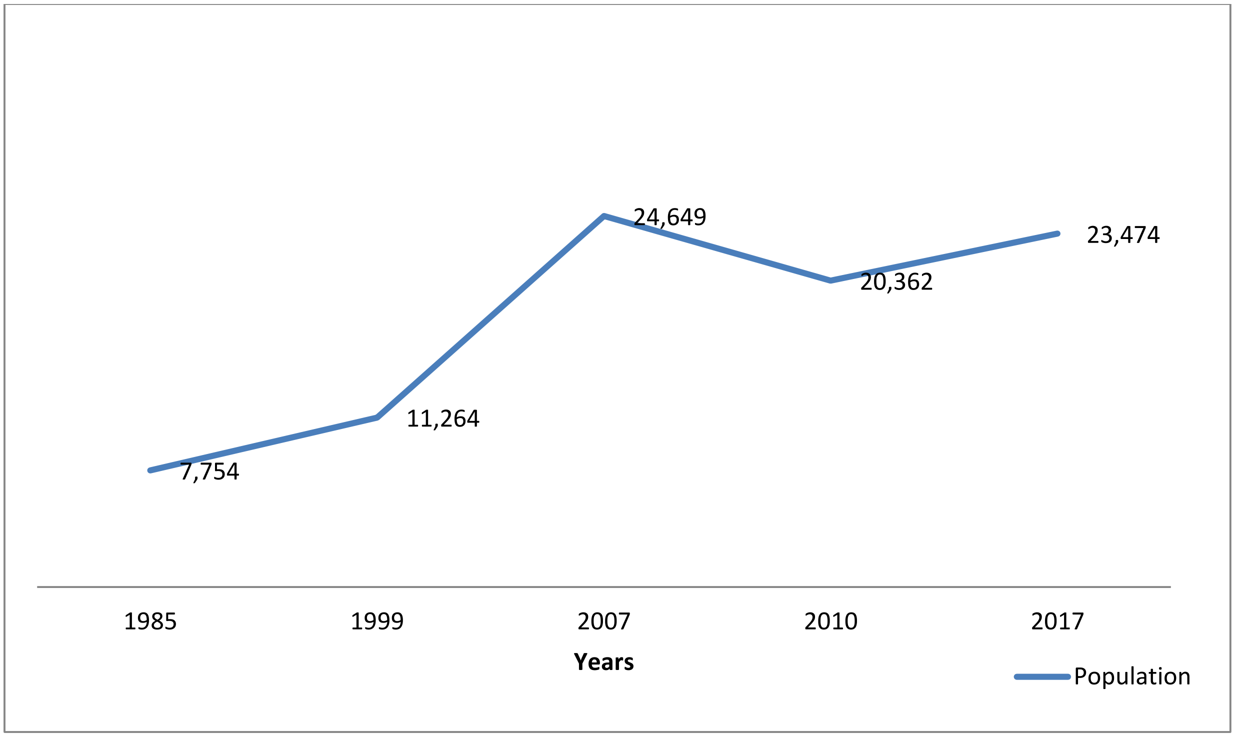

Figure 20: Population trend of the study communities from 1985-2019 (Source: Ghana Statistical Service (GSS, 2012)

The graph shows that population has been increasing from 1985. As shown in fig 14 the population of Ada as at 1985 was seven thousand seven hundred and fifty-four (7,754). The population increased to eleven thousand, two hundred and sixty-four (11, 264) in 1999 and then to twenty-four thousand, six hundred and forty-nine (24,649) in 2007. The population figure decreased slightly in 2010 to twenty thousand three hundred and sixty-two (20,362). It increased again to twenty-three thousand four hundred and seventy-four (23,474) in 2017. The cumulative figures show a general increase in population. However, some of the communities have experienced slower rates of growth while others have experienced negative growth. In communities like Totope and Kewunor population rates have experienced negative growth resulting from flooding, erosion and most importantly loss of place, a significant culture ecosystem service. Figure 21 below shows the population trends for Kewunor and Totope.

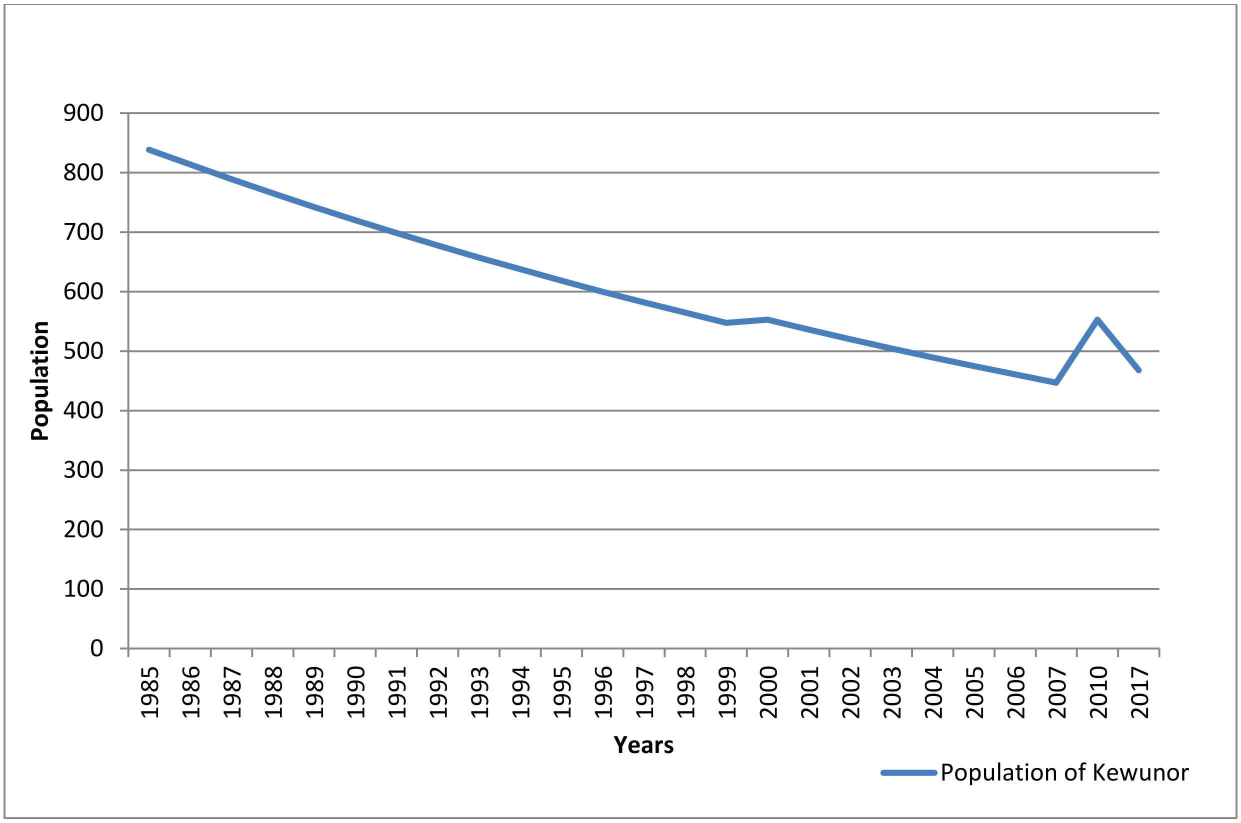

Figure 21: Population of Kewunor (Source: Ghana Statistical Service)

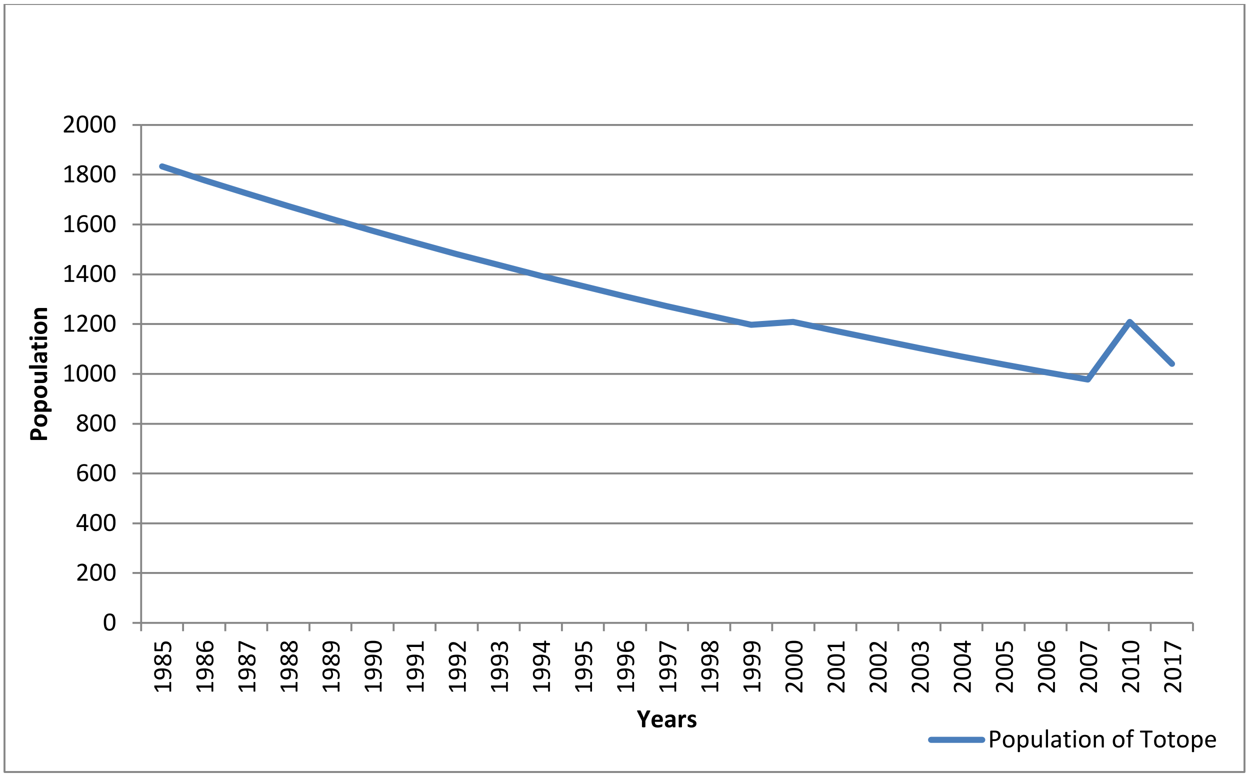

Figure 22: Population of Totope (Source: Ghana Statistical Service)

Figure 21 and 22 show that the population of Totope and Kewunor have been on the decrease from 1985. Some of the factors accounting for this include severe erosion which has led to loss of land to the sea and therefore migration to other parts of Ada. It is important to note that not all communities have experienced negative growths. Some of the communities have experience positive growths albeit the rates are lower than the national average. It is also possible that the growth experienced by the neighbouring communities could have resulted in the migration of people from adjoining towns that have experienced negative rates of growth. Nonetheless, the aggregate rate of population growth in the entire communities was lower at 2.6% which is less than the national average of 3%. Other communities such as Lolonya, Azizanya and Anyamam experienced significant increases in population.

The increase in population has had an impact on demand for housing facilities and other amenities which have contributed to the under developments in the area. The figure 23 below shows how urbanisation has changed the landscape of Ada. Built up areas have increase while areas with vegetation cover have diminished.

Between 1985 and 2017, the vegetation cover has been changing. Between 2007 and 2017, it can be observed that built up area which is depicted by the grey colour along the beach have reduced due to the impact of floods and erosion along the beach. Built-up areas have increased and vegetation cover has reduced significantly. Both grassland and green vegetation have reduced considerably.

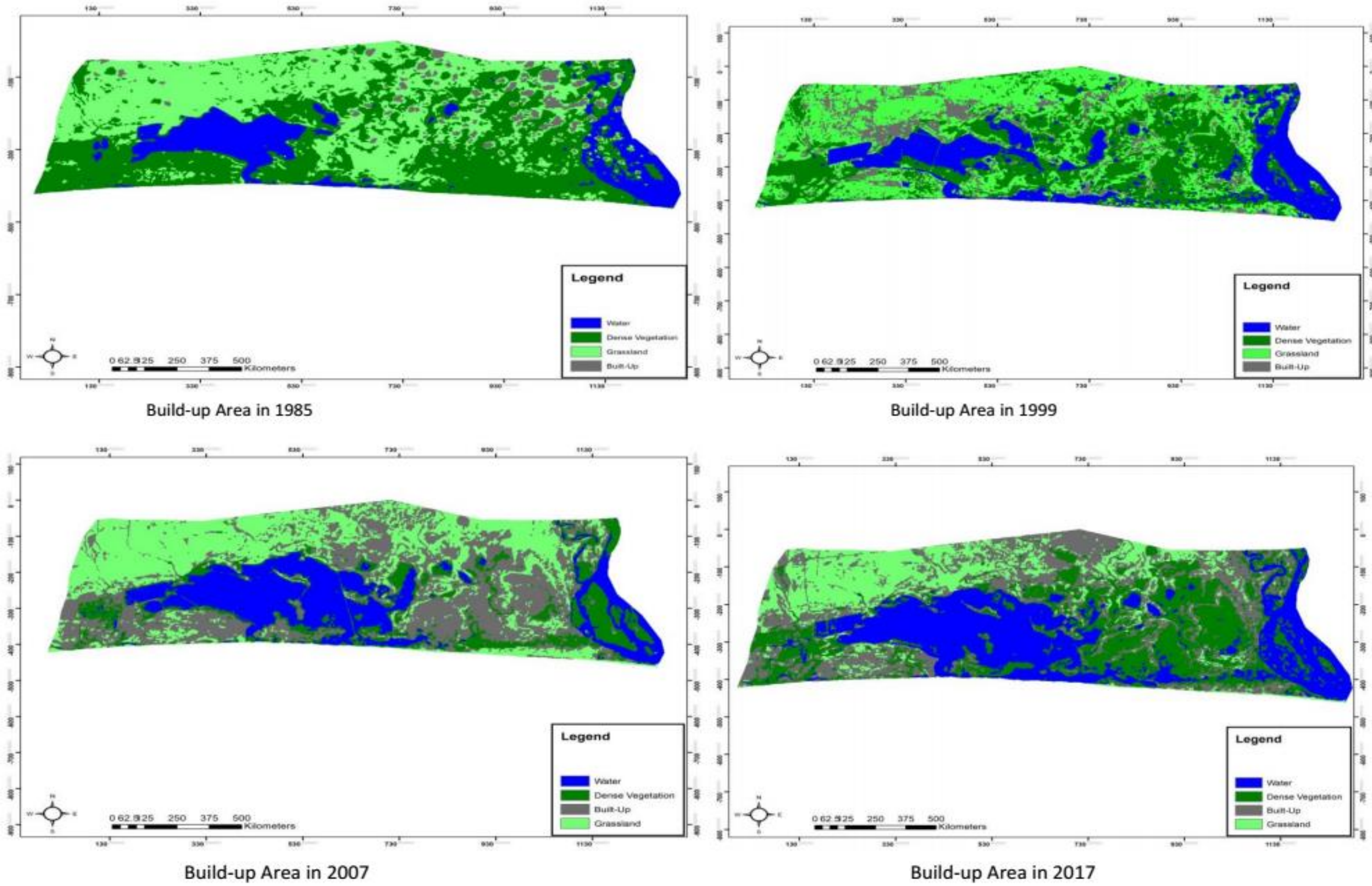

Figure 23: Land use change for 1985, 1999, 2007 and 2017

4.10.2 **Sand Winning**

Sanding winning is a prevalent activity in Ada. It is important however to note that there are two types of sand winning activities. The first type of sand winning activity involves community members moulding blocks with cement at the beach. After the blocks have dried up, they are collected for construction of homes, schools and churches (figure 24). About 97.2% of the participants have observed the occurrence of sand winning. There were however significant variations in the contribution of sand winning to flooding with18.4% and 13.1% of the respondents indicating that the contribution of sand winning to flooding is very high and high respectively. A majority (44.1%) were of the view that the contribution of sand winning to flooding is very low while. 7.5% and 14% were of the view that sand winning caused flooding moderately and low respectively. The second type of sand winning which is less prevalent involves commercial trucks which cart sand for commercial purpose.

Figure 24: Sand winning activity in Ada

These are used to expand their houses or construct new building. The effect is that the beach profile is disturbed, and the elevation is further lowered. This increases the rate of erosion. The picture below shows a degraded beach around Anyamam.

4.10.3 Salt Mining Activities

Several salt mining activities within Ada were observed to contribute to flooding. Salt mining activities between Wokumagbe and Akplabanya and activities by the Songhor salt factory at Lolonya were observed to contribute to flooding. Between Wokumagbe and Akplabanya, salt production factories have constructed tunnels to transport water from the sea to salt pans for salt production. This has led to a blockage of the water way from Ningo into the sea. This is causing severe flooding in the rainy season. Similarly, the construction of an access channel between the sea and the Songhor lagoon to enable sea water flow for salt production is causing disturbance to the Songhor lagoon as excess sand flows in the lagoon, silts it thereby causing flooding when it rains or during high tides. This channel creation is done with a bulldozer. About 7.5% of the respondent viewed this as a major cause of flood. The low percentage results from the fact this problem is not prevalent in all the communities. The main communities directly affected by industrial activities are Wokumagbe, Lolonya and parts of Akplabanya.

Another land use activity that is also contributing to flooding is the construction of dug-outs for fish farming. Several dug-outs have been created at the beach at Goi and abandoned. They are created for fish farming and in the rainy season they overflow and flood the house close to them (figure 25).

Figure 25: Pond at Goi for aquaculture

4.10.4 Siltation of Wetlands

Several areas which could have served at wetlands to reduce flooding have been encroached upon thereby exacerbating the flooding situation. Figure 26 below shows what the locals call the ‘Akplaba River’. This area is normally filled with water during the rainy season and also serves a reservoir for sea water during coastal floods. Due to the intensity of the beach erosion, the area is gradually being reclaimed by fish mongers who are using the space for fish smoking activities. As seen in figure 26 the flood plain is occupied by fish mongers smoking and drying fish. This area is also where they keep their fire wood and smoking trays. Firewood, trays and fish on the dried land gets flooded during rain or storm surge.

Figure 26: Fish mongering activity on River Akplabanya which is dried up

4.10.5 Disturbance of the Songhor Lagoon System

The entire study area falls within the Songhor lagoon Ramsar site. It was observed that the disturbance of this system has contributed significantly to flooding in the area form Wokumagbe to Azizakpe. The area manager of the Wildlife Division of the Forestry Commission expressed concern about the increasing rate of flooding and the impact it has on the communities along the beach. His concern about the causes of flooding is expressed in the following comments;

> *I will say human beings also accelerate flooding because people mine sand at the beach which also causes flooding even though the impact is not that much but ones you create the door for other factors to take*

advantage of it then I think it a cause. We have something we also call channelization, those who drag their boat along the beach sometimes when they are moving the boat into the beach, the sand is very loose so once they drag the boat at a particular place for a long time it creates some channel that is also an avenue for erosion to set in basically this are the causes of flooding. All these affect the Songhor system.

This statement from the wildlife department exemplifies the impact of anthropogenic activities on the Songhor system. This has led to the reduction in the number of migratory birds and reduced bird watching as tourist activities. The reduction is the sandy beach is also affecting the sea turtles which lay eggs in the sand.

4.11 Recommendations Towards Addressing Flooding in Ada

Respondents recommended varied solutions to curb flooding in Ada. Most of the respondents (35.6%) were of the view that expanding the sea defence to cover that stretch from Totope to Wokumagbe will help reduce the incidence of flooding in Ada. This was followed by 18.6% of respondents who recommended the construction of landing beaches. Respondents who recommended dredging of the river represented 19%. Other recommendations were dredging of wetlands, construction of roads relocation and construction of bridges which constituted 5.5%, 2.5%, 2.4% and 3% respectively. These are shown in figure 27 below.

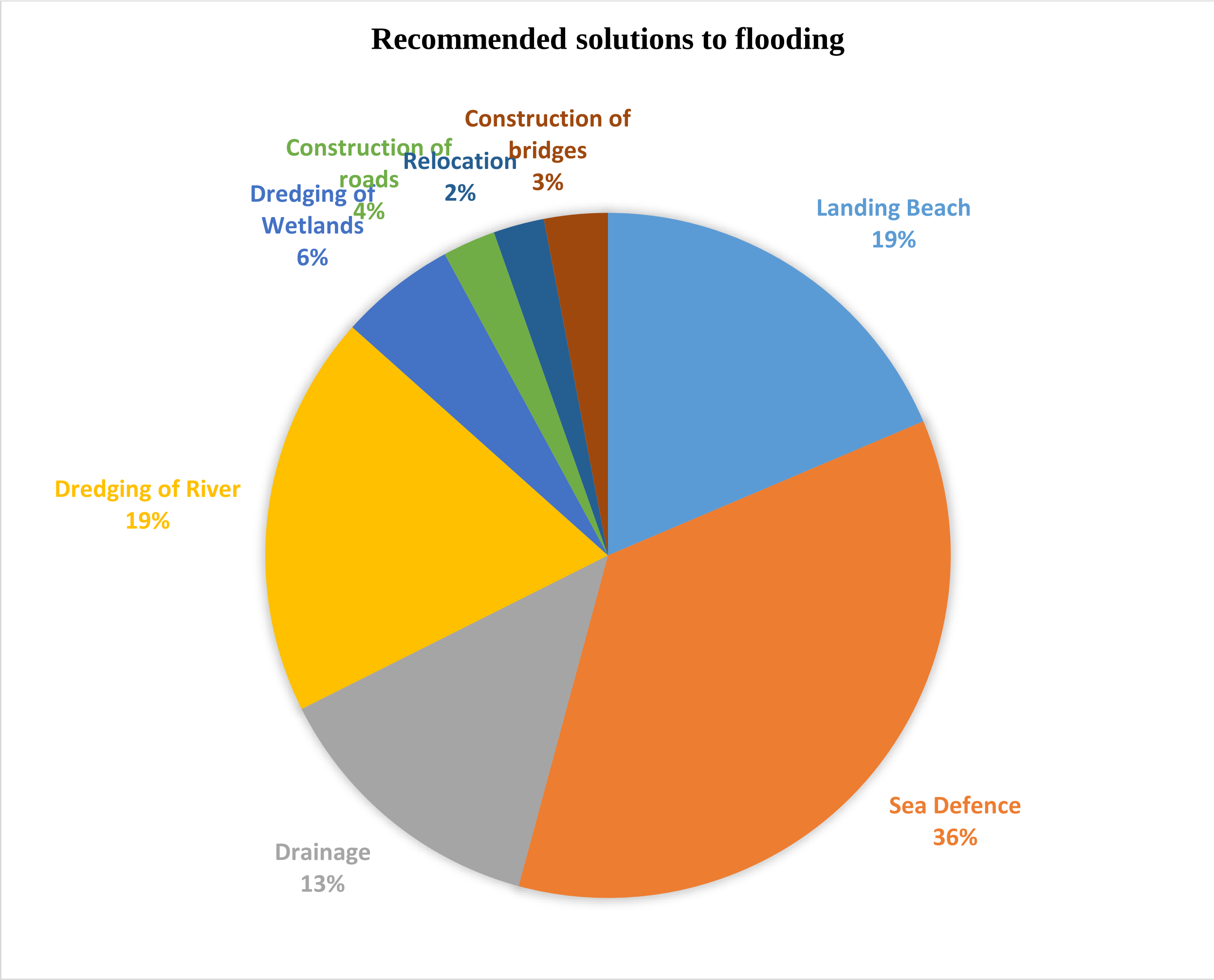

Figure 27: Recommendations towards solving flooding in Ada

4.12 Evaluation of the Status of Cultural Ecosystem Services and the Impact of Flooding on Cultural Ecosystem Services

This section presents findings on ecosystems that were identified in Ada and quantitative and qualitative analysis of the status of cultural ecosystem services. Again, structural equation model is used to validate the effect of flooding on cultural ecosystem services.

4.12.1 Ecosystem Services in Ada

Ten different ecosystem types were identified in Ada (Figure 28). These include sea, sandy beaches, river, wetlands, grassland, forest, dryland, island and marshes. The most significant ecosystem type is marine or sea system. This is followed by sandy beach, cropland, etc. Some other ecosystem types that were reported during focused group discussion include coconut vegetation and mangroves.

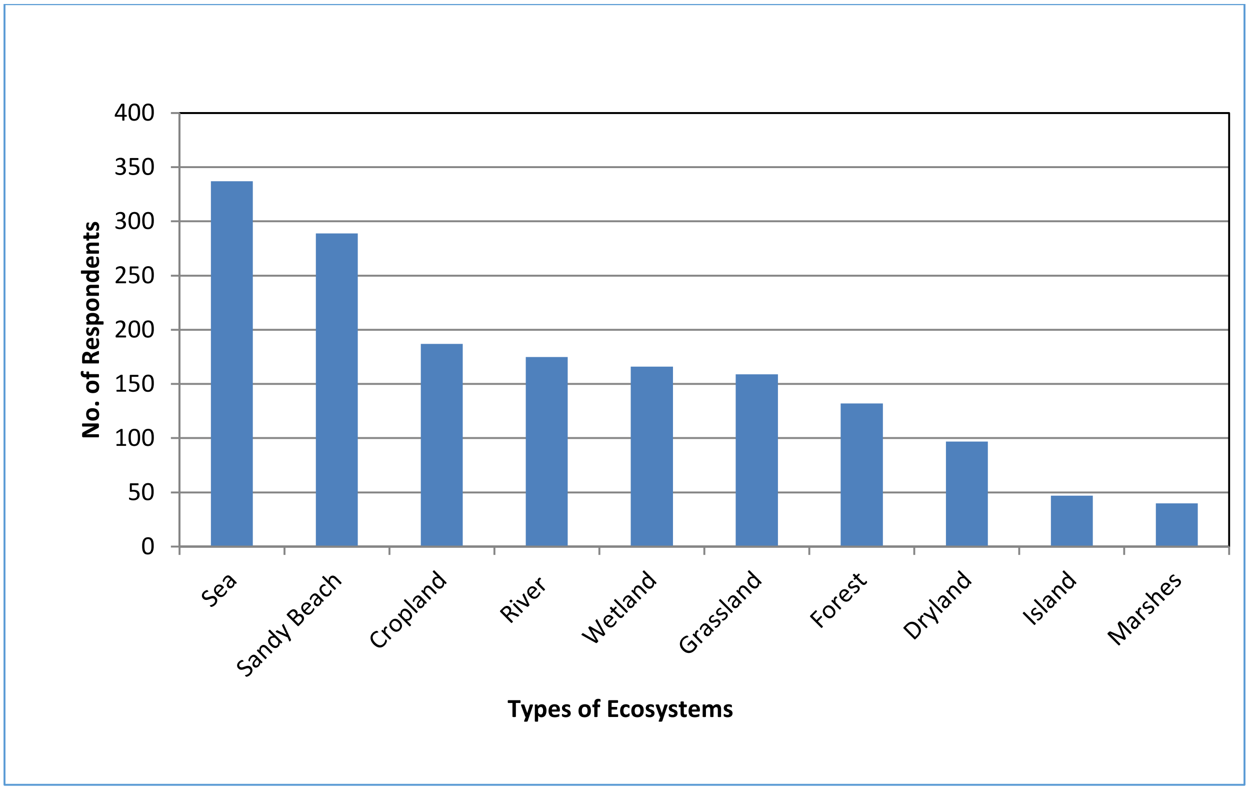

Figure 28: Ecosystems in Ada

4.12.2 Cultural Ecosystem Services in Ada

Cultural Ecosystem Services benefits are prevalent in Ada. About 15 different cultural ecosystems services were identified. The CES identified are derived from diverse ecosystems. Place or place attachment or sense of place, cultural livelihood and recreation recorded mean responses of 4.43, 3.97 and 3.37 respectively (Figure 29). The most important cultural ecosystem services are Place, cultural livelihood, recreation and aesthetic. It is important to state that even though aesthetic recorded low response, its importance is underscored by the fact that most of the participants in the focus group discussion narrated how the landscape around Ada has changed compared to what it was many year ago.

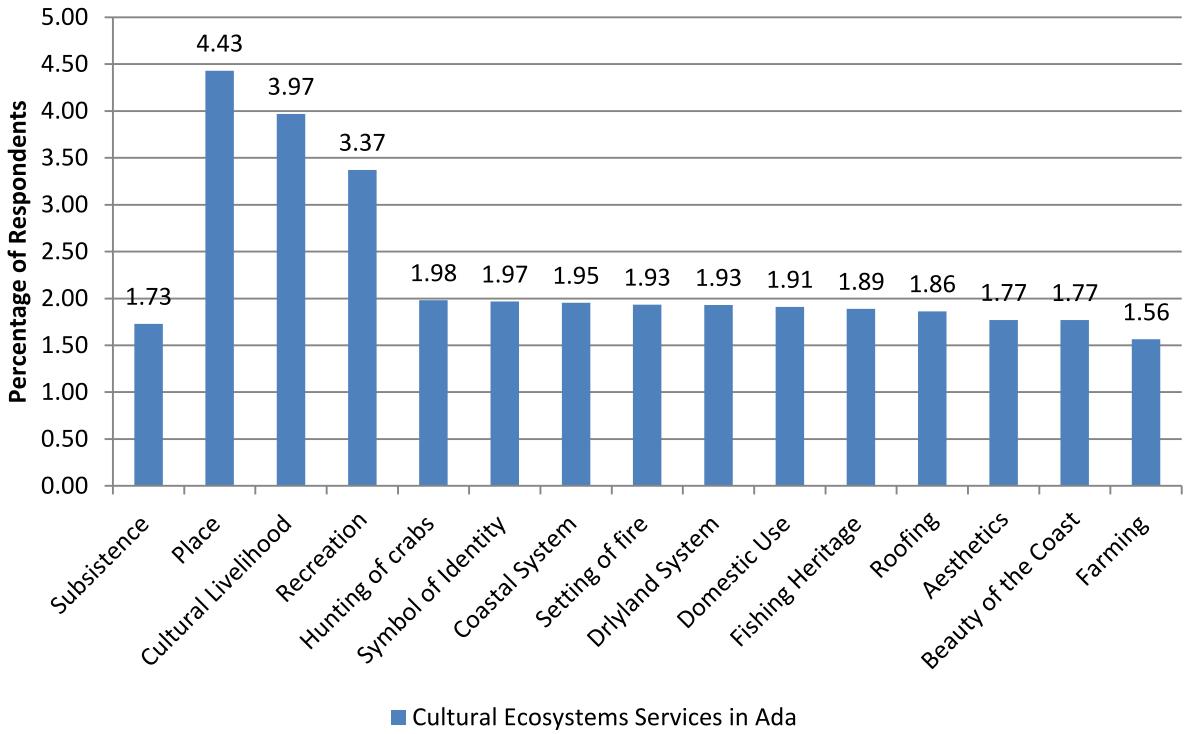

Figure 29: Cultural Ecosystem Services in Ada

Figure 30 shows the most important cultural ecosystems service in Ada. It is important to stress that while quantitative data showed a low response towards aesthetic cultural ecosystems, qualitative data shows that aesthetic cultural ecosystems services is very important to the people of Ada.

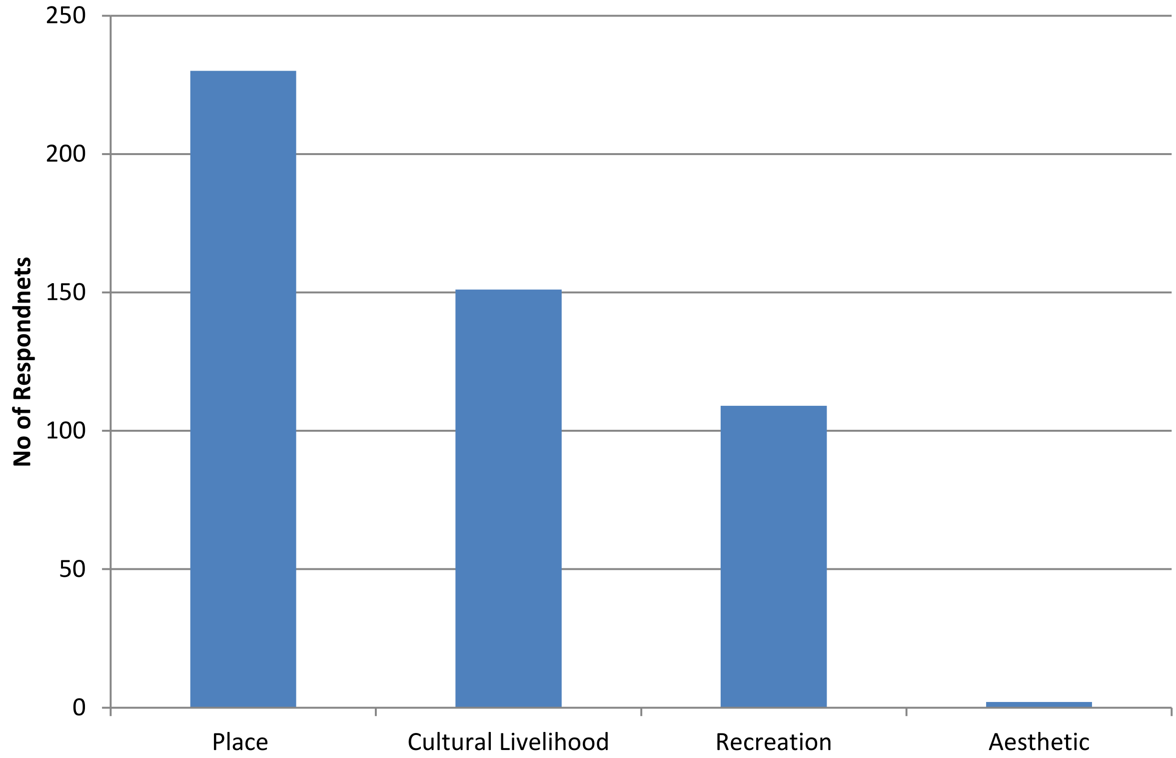

Figure 30: Main Cultural Ecosystems in Ada

4.12.3 **Importance of Place as Cultural Ecosystem Service**

Place is considered as an important cultural ecosystem service by most of the participants in the study. The majority of respondents (85.7%) considered Place as an important ecosystem; comprising of 64.5% of the respondents who considered it as extremely important, and 21.2% to be very important (table 23).

Table 23: Importance of place as Cultural Ecosystem Services

Importance of Place	Frequency	Percent
Not important at all	7	2.0
Not important	12	3.4
Important	32	8.9
Very important	76	21.2
Extremely important	231	64.5
Total	358	100.0

Many Places have been lost in Ada leading to the loss of several years of historical connections between people and places. Table 23 below shows some of the cultural ecosystem services associated with places that have been lost. Most of these places have been lost to the sea through erosion and floods. Loss family homes constitutes about 16% of places that have been lost. Churches also constitute 13% most of which are the Divine Healer Churches. Recreational facilities and Shrines constitute 11.4% and 10.80% respectively. Other residents have migrated to neighbouring communities leaving behind their place. Family homes and churches are the most lost place followed by schools and agricultural lands. Communal parks also scored high response from respondents.

Table 24: Cultural Ecosystems Services that have been Lost in Ada

No	Cultural Ecosystem Services Lost due to Flooding	Percent
1	Churches	13.80%
2	Mosques	0.50%
3	School	8.80%
4	Cemeteries	5.80%
5	Agricultural Lands	9.20%
6	Family homes	16.00%
7	Recreational Areas	11.40%
8	Shrine	10.80%
9	Communal Parks	8.90%
10	Historical Sites	2.60%
11	Markets	1.60%
12	Roads	3.60%
13	Shops	1.10%
14	Land	1.20%
15	Fuel Station	0.10%
16	Toilet	0.30%
17	Coconut Vegetation	4.30%
	Total	100.00%

Table 24 shows some of the places that have been lost

The physical environment around Ada has changed. About 70% of the participants in the focused group discussions were of the view that the environment has changed compared to when they were growing up. Many coconut trees have been lost and Places where they use to have social activities have been lost due to flooding and erosion. In 2011, about 147 houses were affected by flooding in Ada while in 2012, about 79 houses were affected (Source Fieldwork, 2019). Between 2011 and

2016, a total of about two hundred and sixty-three houses have been affected by flood. The number of houses that were completely lost to the sea cannot be estimated however, accounts from residents indicate that a significant number of houses were lost. Some of the affected residents had to seek refuge from relatives and adjoining communities.

4.12.4 Place Attachment

The significance of place attachment in the cultural ecosystem discourse is derived from the fact as Massey and Jess (1995) noted “Places are unique, different from each other; they have singular characteristics, their own traditions, local cultures and festivals, accents and uses of language; they perhaps differ from each other in their economic character… it couldn’t be anywhere else”. The victims of flooding in Ada do not necessarily migrate into different cultural as postulated by Massey and Jess. However, losing family homes and historically known places can have implications for sense of security and identity. The residents of Azizakpe fear that the entire island would be lost soon if there is not intervention by district assembly.

4.12.5 Importance of Aesthetic as Cultural Ecosystem Service

Among the cultural ecosystem services that are considered important to respondents, aesthetic value of cultural ecosystem service was considered not very important by a significant number of respondents (76.3%). This implies that only 23.7% of the respondents consider the aesthetic value of cultural ecosystem services as important. This is due to the perception and understanding of aesthetics. In the focus group discussions, residents lamented how the beach has changed and vegetation along the beach used to be very beautiful. They mentioned the presence of coconut trees which have all been lost to the sea. They recalled how they use to walk along the beach. Sense of landscape beauty among the residents is very high and this accounts for the inclusion of aesthetic as one of the important cultural ecosystems service. Table 25 below depicts the importance of aesthetic cultural ecosystem service.

Table 25: Respondents' consideration of the importance of Aesthetic Value of Cultural Ecosystem Services.

Importance Aesthetic Value	Frequency	Percent
Not important at all	170	47.5
Not important	103	28.8
Important	83	23.2
Very important	2	.6
Extremely important	0	0.0
Total	358	100.0

4.12.6 Change in Vegetation along the Beach

Change in vegetation along the beach has been very extensive according to participants in men's focus group discussion held at Akplabanya. A member of the groups' said that;

> *...with all the coconuts gone now the sun shines directly on us making exposure to the sun quite terrible. Actually, the vegetation was quite beautiful because apart from the coconut trees, there were other vegetation types which could be seen around this place.*

His comments depict how vegetation has changed from what it used to be. Apart from coconut vegetation, there were mangroves, acacia and diverse vegetation. These made the landscape rich and serene. According to residents even the smell at the beach has changed.

4.12.7 **Urbanisation**

The fact that many people are building around the beach means that the landscape is changing and this will continue because the population keeps increasing. With increasing population, many domestic, commercial and industrial properties have sprung up. At the time of the study, feasibility studies for the construction of a five-star hotel had been completed and the contractor had moved to site with equipment. Some community members were going to be affected by this activity. It took the intervention of the wildlife department to stop this construction because the area is a protected area and turtles were being affected.

4.12.8 **Historical Richness**

Participants in the focus group discussions and key informants and elderly members of the communities recounted how the beach was nice and intact. Even the colour of the sand was whiter compared to what it is now. The entire landscape has changed considerably. The greenery and the coconut vegetation have all been lost due to the erosion and flooding which affects the vegetation.

4.12.9 **Beach Littering**

"*The beach front has changed with litter or rubbish all around"*. Especially when it rains the water "brings plastic to the beach because the sea will reject". Though the quantity of garbage could be estimated in tonnage, participants in the focused group discussion complained about the increase rubbish both along the shore and in the sea. The catch from the sea nowadays is always mixed with all types of waste. This makes the beach filthy and unpleasant.

4.12.10 **Recreation**

Recreation is an important cultural ecosystem in Ada. At different scales, a total of 73.7% of the respondents consider recreation as an important cultural ecosystem service. More specifically, 30.4%, 19.8% and 23.5% of the respondents consider recreation to be extremely important, very important and important respectively (Table 26).

Table 26: Respondents' consideration of the importance of Recreation as Cultural Ecosystem System.

Importance of Recreation	**Frequency**	**Percent**
Not important at all	62	17.3
Not important	32	8.9
Important	84	23.5
Very important	71	19.8
Extremely important	109	30.4
Total	358	100.0

4.12.11 **Shoreline Fluctuation, Accessibility and Recreation**

According to one of the key informants the littoral area along the beach has reduced significantly making the use of the beach uninteresting. Shoreline change is validated in earlier section and its impact on recreation is expressed by the local people in the communities. The main Ada beach is not as wide as it was previously hence recreational activity there has reduced. The beach is not as accessible as it was especially with the construction of groynes. People are not able to use the beach like before.

4.12.12 **Cultural Livelihood**

About 42.2% of the respondents considered cultural livelihood as an important cultural ecosystems service while 27.4% of the respondent surveys viewed cultural livelihood as very important. The two responses represent about 69.6% of the respondents. An additional 17.6% of the respondents are of the view that cultural livelihood is important. Altogether, 87.2% of the respondents consider cultural livelihood as an important cultural ecosystem service. This is shown in table 27 below.

Table 27: Importance of Cultural Livelihood as Cultural Ecosystem Service

Importance of Cultural Livelihood	**Frequency**	**Percent**
Not important at all	7	2.0
Not important	39	10.9
Important	63	17.6
Very important	98	27.4
Extremely important	151	42.2
Total	358	100.0

Cultural livelihoods activities which reinforce the importance of this cultural ecosystem is described in the following sections.

4.12.13 **Domestic Activities**

Most of the women along the river use water from the river for household chores like cooking washing of dishes and bathing. Sometimes they use fish from the river and crab to prepare daily meals. Until recently when the water has become contaminated, virtually all aspects of daily lives depended on water from the river. Another important aspect of domestic activities is health. As the inhabitant puts it, "the *sea is medicine*". It is used to cure several ailments that afflict the community. Different kinds of skin diseases are cured with sea water.

4.12.14 **Tradition and Custom**

Communal values, taboos, rituals and customs that have been practiced by the indigenes for a long time have been affected by flooding. Some of these traditions have been modified to adapt to prevailing conditions. For instance, even though people were barred from going close to the forest at Anyamam, people are now farming close to the forest because of the need to get additional land for cultivation. People are also building close to the forest. At this rate, the forest is likely to be lost sooner than later. The 'home" of the Ada ancestors would be a story to be told. The taboos that have been evolved by the people of Azizakpe and the cultural diversity it represents would be lost with the loss of the island.

4.12.15 **Heritage- Agricultural, Custodian of Land**

Both men and women participants in focus group discussions participate in salt mining, fishing and farming because these activities were inherited from their grandparents. "*What we know is the sea… fishing is all we know how to do. If we have to leave here, we wouldn't know what to do"*. These are the words of the chief of Azizakpe. Similar sentiments were expressed by one of the elders of Totope. In 2013, eight acres of agricultural lands were lost due to flooding (NADMO:

personal communication). These lands were affected by salt intrusion and made the soil infertile. Many agricultural lands are lost to salt annually as a result of salt intrusion from flooding.

4.12.16 Apprehension About the Future

Residents in the communities live in apprehension especially those who live close to the sea because they are not sure when flood events will occur. As stated by a resident, *"we are always unsure when the sea will come for them"*

4.13 Effects of Flooding on Place, Cultural Livelihood, Recreation and Aesthetics

Table 4.0 presents the mediation effect of flooding on place, cultural livelihood, recreation and aesthetics. The mediation effect of flooding was significant showing a significant path relationship to the latent variable "Place, Cultural livelihood, Recreation and Aesthetics". Moreover, using Schumacker and Lomax, (2004) criteria which states that the value of RMSEA must be less than 0.05 is considered as significant. The RMSE for effect of flooding is (0.000) implies that the mediating effect provide a satisfactory fit for this model. Hu and Bentler (1999) recommended that values of CFI and TLI must exceed 0.95 for the path to be considered as significant. The results in Table 28 shows that all the variables under place, cultural livelihood, recreation and aesthetics are jointly significant ($CFI = 1.090; TLI = 1.116$).

Table 28: Effects of flooding on place, cultural livelihood, Recreation and aesthetics

	Variables	Coefficient	Std. Err.	z-value	p-value	RMSEA	CFI	TLI
Place	Flooding	0.15	0.05	2.70	0.01	**0.004**	**1.090**	**1.116**
	constant	4.03	0.16	25.75	0.00			
Cultural Livelihood	Flooding	0.40	0.06	6.68	0.00			
	constant	2.85	0.18	16.12	0.00			
Recreation	Flooding	0.13	0.07	1.93	0.05			
	constant	3.44	0.19	17.85	0.00			
Aesthetics	Flooding	-0.02	0.05	-0.33	0.74			
	constant	1.81	0.14	12.94	0.00			

Table 28 represents the path coefficient for the structural model. The path is divided into two effect; the first effect measures the impact of Anthropogenic and Climatic drivers on flooding whiles the second focused on the impact the flooding on place, cultural livelihood, recreation and aesthetics as shown in figure 30.

In the first part, the results revealed that both Anthropogenic and Climate are significant predictors of flood. Thus, the coefficient of Anthropogenic is 0.64 implies that the full effect constraint towards flooding and holding the other variables as constant. The estimated positive sign implies that such effect is positive that Anthropogenic would increase by 0.64 for every unit increase in constraints and this coefficient value is significant (p-value = 0.000) at 1% level. Also, the coefficient of Climate is 0.42 denoting full effect constraint towards flooding when all other variables remain constant. More so, the calculated positive sign implies that such effect is positive and that Climate would increase by 0.42 for every unit increase in constraints and this coefficient value is significant (p-value = 0.000) at 1% level.

In the second part, the study examined the mediation effect of flooding on place, cultural livelihood, recreation and aesthetics. The path analysis results indicate that the effect of flooding is a significant predictor of place with a coefficient of 0.015 and a p-value of 0.01. Also, mediation effect flooding is statistically significant predictor of cultural livelihood and recreation with respective p-values as 0.00 and 0.05 but insignificant predictor of aesthetic since the p-value exceed the threshold of 0.05 level of significance. This implies that the effect of flooding has a direct impact on place, cultural livelihood and recreation as represented in the figure 31 below.

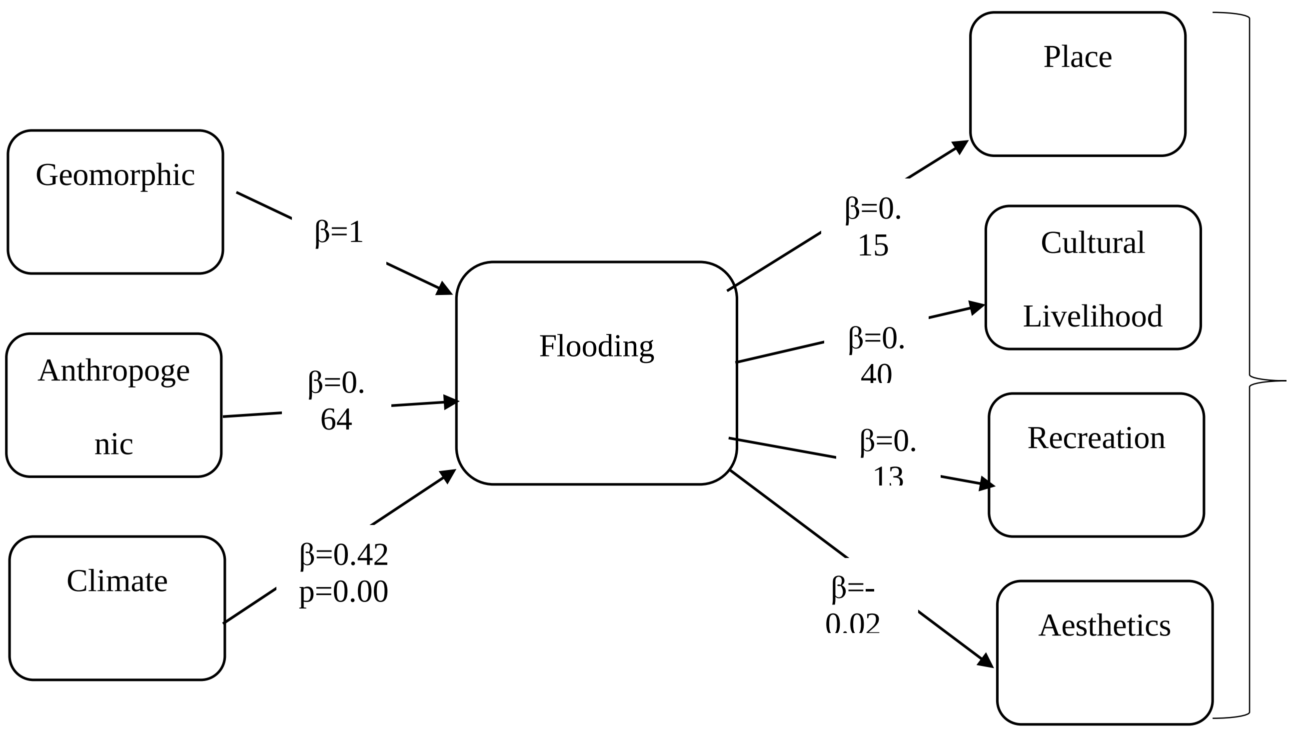

Figure 31: Structural model showing the relationship between flooding and cultural ecosystem service and the coefficients.

4.14 Application of the Bayesian Network Model as a Decision Support Tools in the Management of Cultural Ecosystems Services.

The Bayesian Networks model as a decision support tool is important and useful in determining the implication of coastal flooding on cultural ecosystems services in Ada. To assess the current impact of flooding on cultural ecosystem services, current data was imputed into the model. The results showed that based on current data climatic drivers are having severe impacts on flooding. Non-climatic drivers marginally contribute to flooding. A combination of the climatic, non-climatic and geomorphic factors is causing high levels of flooding as shown in figure 31 below.

The graphs (figure 32, 33, 34) below represent various scenarios for flooding given the states of the drivers of flooding they show the state of flooding at extreme values of high, low and medium respectively. Figure 32 shows that when all the drivers of flooding record extreme values, the level of flooding will be high. These variables are the climatic, anthropogenic and geomorphic drivers. The climatic variables include tidal levels, wave and wind speeds, rainfall. Anthropogenic drivers are land use change, population, urbanisation and sand mining. The geomorphic feature are elevation and erosion.

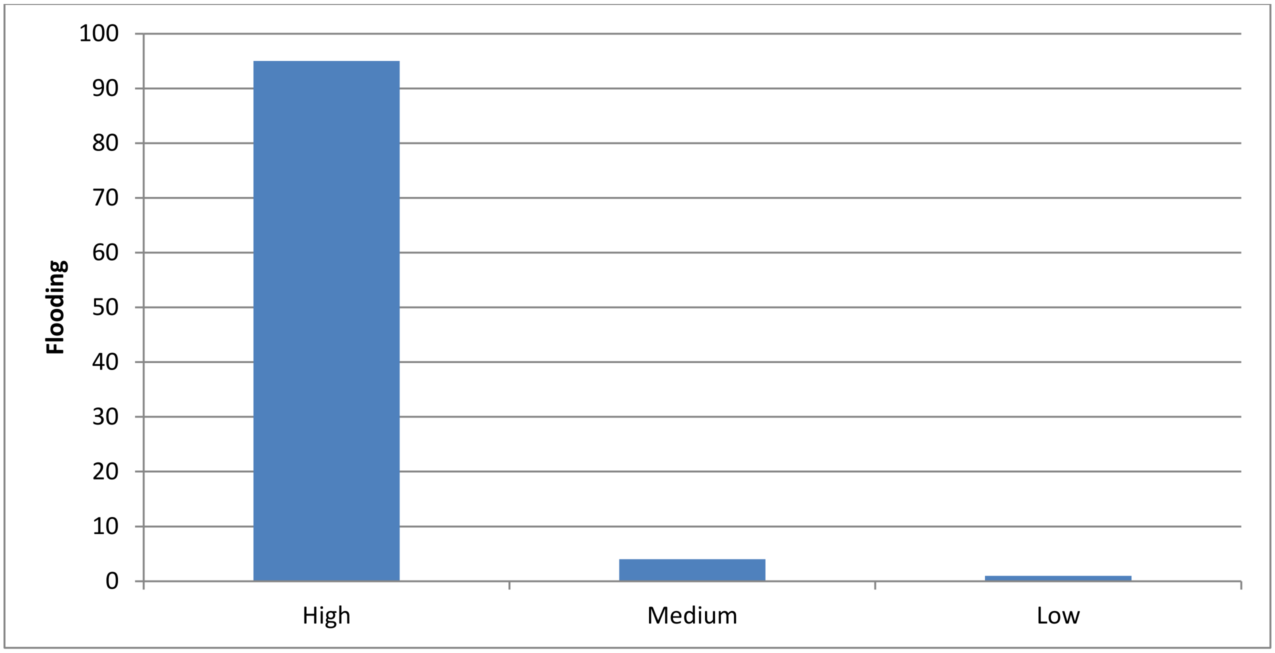

Figure 32: State of flooding when all drivers record extremely values

When the drivers of flooding are at medium level the state of flooding is as shown in the figure 33.

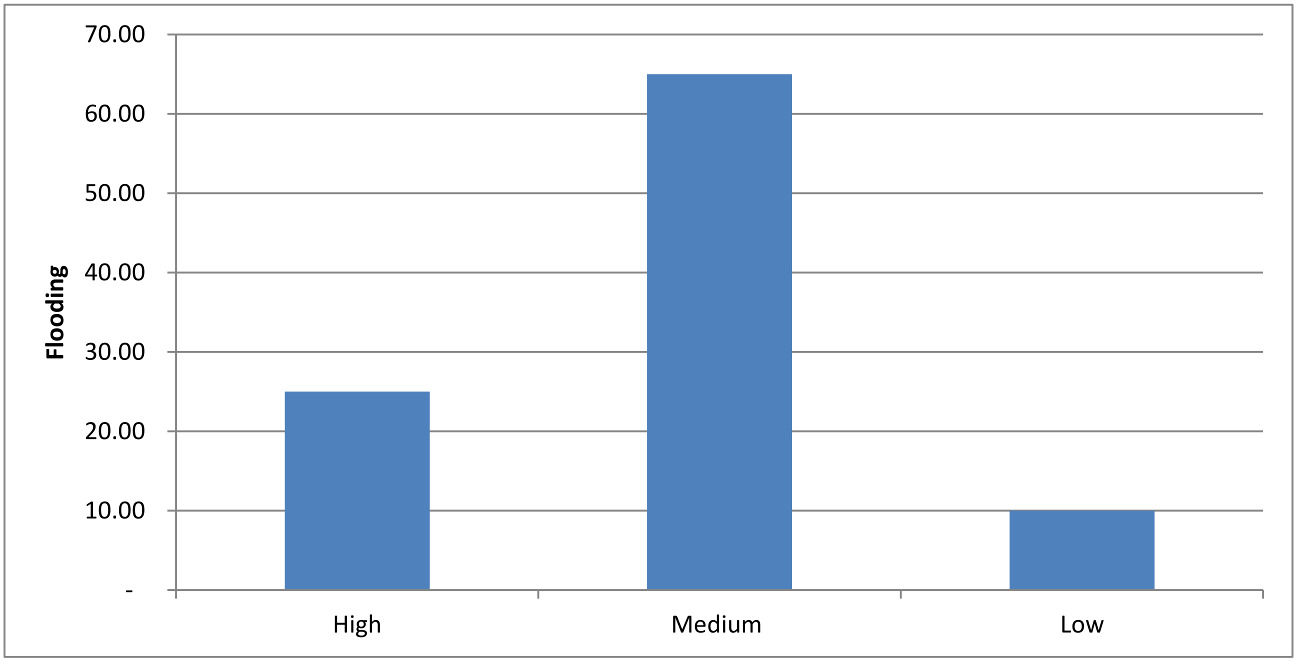

Figure 33: State of flooding when all drivers record average values

Figure 34 shows the state of flooding when the values recorded for the drivers of flooding are low. Based on the model however, different variable states enable us to see the impact of flooding and cultural ecosystem services which can inform decision-making.

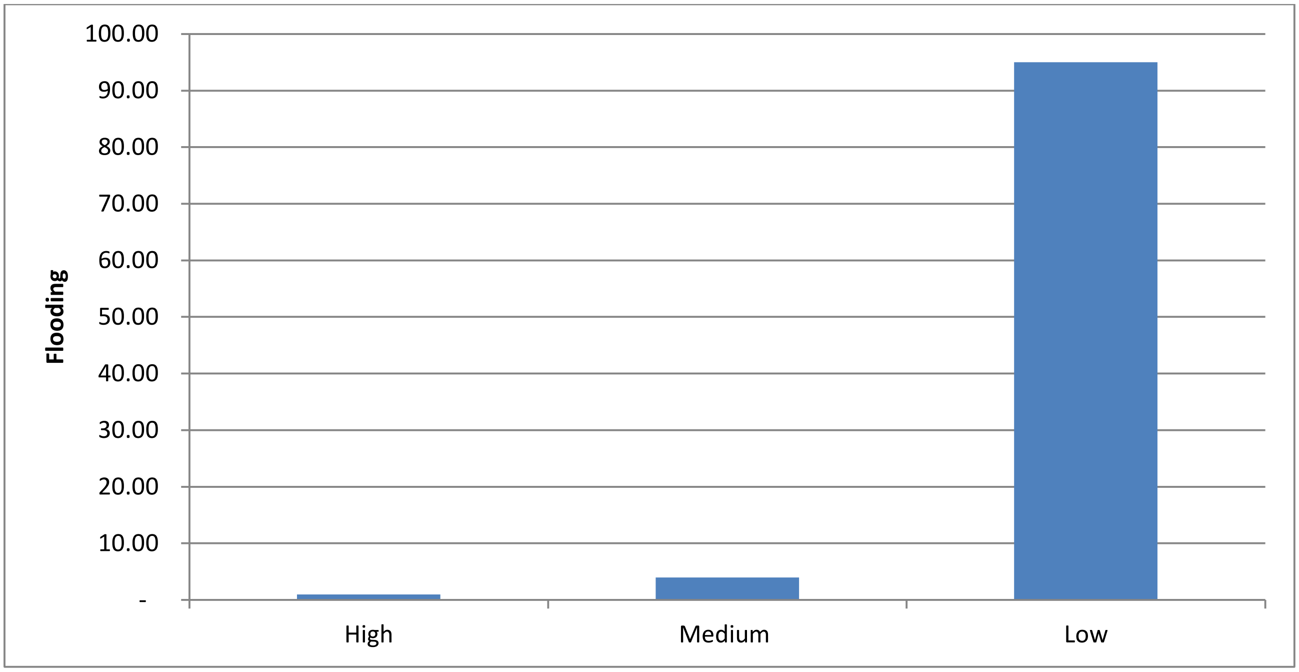

Figure 34: State of flooding when drivers record extremely low values

The results from the model shows that with adequate policy interventions, there is 51% chance that cultural ecosystems will improve compare to a 57% chance of cultural ecosystems services being poor with inadequate policies to deal with flooding.

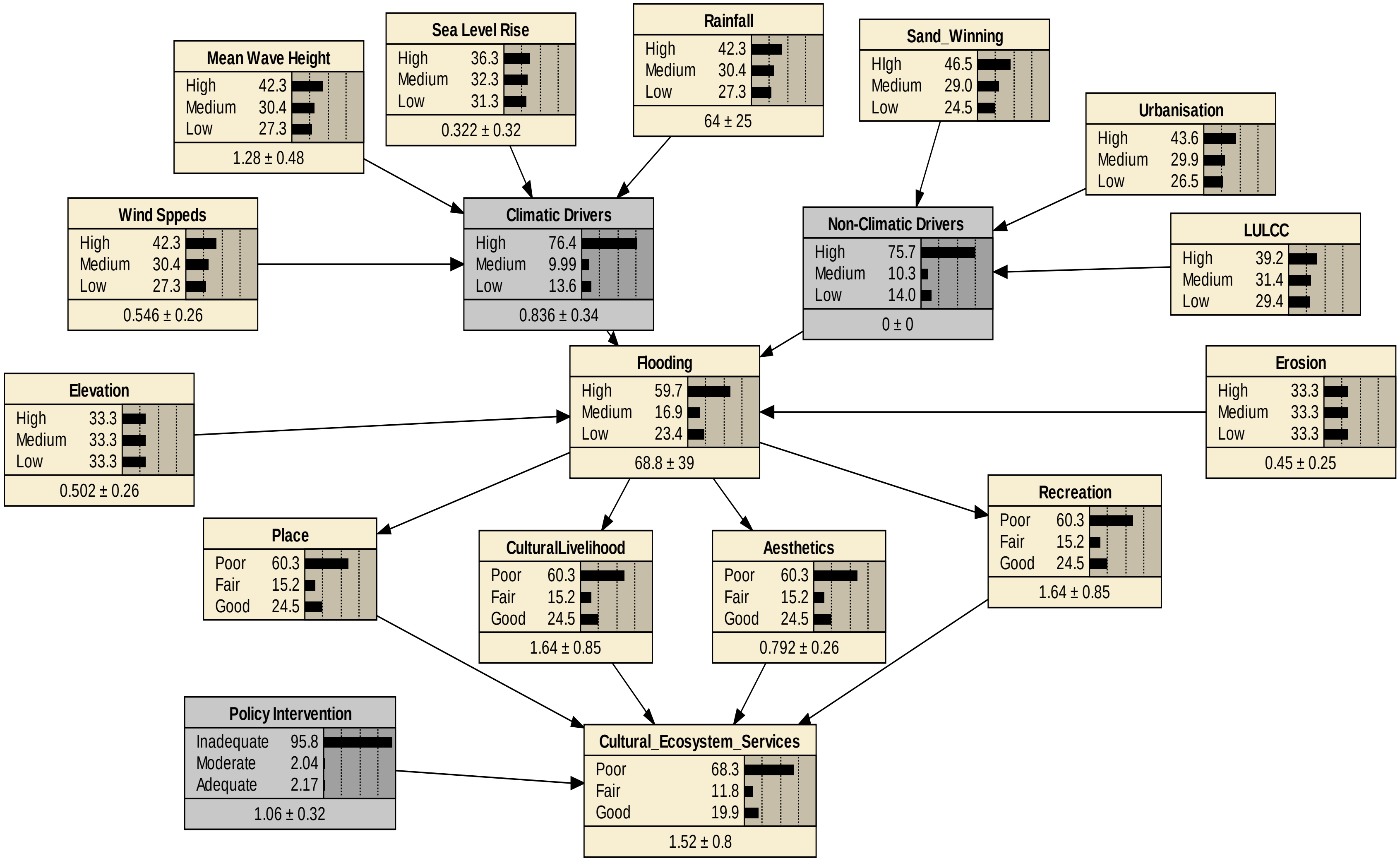

Figure 35: Prevalence of flooding based on the conceptual model

4.15 Summary of results

Understanding the drivers of flooding in Ada is important due to the prevalence of the flooding episodes. The majority (98%) of the respondents in Ada have experienced flooding in its different forms. Information prior to flooding is poor as 82.7% of respondents reported that they do not receive information. Of those who received information prior to flooding, 85% of them indicated that they received information through the radio. Most of the respondents (90.2%) reported that assistance during flooding events mostly comes from the NADMO.

The results showed that there are climatic, anthropogenic and geomorphic drivers of flooding in Ada. The main climatic drivers are sea level rise (24%), rainfall (19.5%) and storm surge (17.2%). The anthropogenic drivers include sand mining (5.5%), land use and vegetation change (1.2%), population growth and urbanization (2.2%). The geomorphic drivers are elevation i.e, geology which influences the extent of erosion and siltation of the river bed. Local perceptions of the drivers of flooding are consistent with theory and respondents attributed the causes of flooding to climatic drivers. The results showed that anthropogenic drivers although prevalent in Ada, contribute less to flooding. This finding is contrary to Wong (2014) who notes that coastal flooding is caused by both climatic and human factors. Further confirmatory analyses to establish the relationship between the drivers of flooding and flood yielded a significant path relationship between the drivers of flood and flood as the resultant root means square error of approximation (RMSEA) was below 0.05 for all the categories of drivers. Another driver of flooding is erosion which between 1985 and 2017 has been occurring are a rate of -3.84 meters per annum. Erosion leads to loss of land and causes the littoral areas to reducing thereby bring the sea closer to residents' homes. It was instructive to note that while generally population in Ada has been increasing, places such as Azizakpe and Totope that have experienced significant flooding and erosion have recorded reduction in population. Rapid urbanization in Ada also means that there has been significant land use change which also exposes people to the risk of coastal flooding. Disturbance of the Songhor lagoon system also contributes to flooding as people (around Totope) attempt to reclaim portion of the lagoon for residential purpose. This exposes them to flooding when it rains or during storm surge. Various measures have been proposed to curb flooding. Some of these include reconstruction of the sea defense groynes in Ada Foah. Most of the residents make reference to the one in Keta as a better defense. Other recommendations include dredging of the river regularly.

Several ecosystems were identified in Ada. Among others, the ecosystems identified include sea, forests, sandy beaches, marshes, mangroves, river, lagoon, cropland, etc. These ecosystems are important to the residents as they define the way of life of the people of Ada. Some of the ways in which ecosystems define the residents' way of life include recreation, subsistence, festivals, livelihoods etc. The ecosystems provide provisioning, regulating, support and cultural services. The study observed that cultural ecosystem services have been significantly affected by flooding. Principally, place, which is a crucial cultural ecosystem has been affected because of loss of place, Loss of place has implication of sense of identity and place attachment. Coastal floods have uprooted people from their place leading to migration and loss of family history. Apart from loss of place, other cultural ecosystem services that have been lost include aesthetics, recreation and cultural livelihoods. Cultural livelihood as a cultural ecosystem service has been identified as a new typology that needs to be added to the expanded typology by Gould and Lin

Analyses to confirm the relationship between flooding and cultural ecosystem services also showed a positive path relationship between flooding and cultural ecosystem services. This means that there is a relationship between flooding and the status of cultural ecosystem services i.e. place, recreation, aesthetics and cultural livelihood.

Future implications of flooding for cultural ecosystem services was modelled using the Bayesian network model to support decision making in future. Based on variable determined from field data and literature which were subjected to expert review, the relationships between and among the variables were validated. Conditional probability tables were developed to determine the possibilities that are likely to result depending in the states of the variables. The result showed climatic drivers of flooding are a significant contributor to flooding and measures to address flooding should focus on reducing the pressures from climatic drivers. When climatic drivers exacerbate, flooding will increase and the corresponding effect on cultural ecosystems will be dire. Even among the climatic drivers, sea level rise contributes more to flooding and push people backwards from the coast. Geology of the coast and elevation also combine with climatic factors to worsen the status of cultural ecosystems services. While noting that anthropogenic factors also contribute to flooding in Ada, the model showed that the effect of anthropogenic drivers on flooding are not significant.

CHAPTER FIVE

5. Discussions

5.1 Introduction

This chapter presents discussions of the results that have been presented in chapter four. It starts by discussing the types of flooding and the local perceptions of the drivers of flooding. It also discusses the impact of flooding especially from gender perspective and discusses ecosystems and culture and how the loss of ecosystems induced by flooding is affecting cultural ecosystems services. Finally, it discusses the future implications of coastal flooding for cultural ecosystems based on the Bayesian model.

5.2 Perceptions of Drivers of Flooding

Flooding is a widespread phenomenon in Ada and perception of the causes of flooding is mostly climatic. There is no strict dichotomy between climatic and non-climatic drivers of flooding as non-climatic causes of flooding are not admitted by residents. Many of the respondents do not easily admit that some of the human activities contribute to flooding. Factors that were mentioned as the causes of flooding include, erosion, sea level rise, tidal waves, rainfall and river tides. The following sections describe and discuss into detail, the various causes of the flooding and classification of the drivers.

5.2.1 Perceptions of Climatic Drivers of Flooding

The concept of sea level rise is prevalent among the indigenes of Ada. Various narratives were presented to describe sea level rise. An opinion leader in Azizanya in describing sea level rise said; "*they say there is some ice which is melting somewhere and causing the sea to go up and that is* *the problem*". Residents note that they have observed that the sea keeps going up and it is the reason why the sea keeps covering the land because the sea was previously "far away". Some estimated the previous distance from the sea to the community at about one kilometer while other residents estimated it at about 500 meters. The rate at which the sea is rising is alarming to the extent that many communities such as Azizanya and Akplabanya (old town) will soon be wiped out. Until the construction of the sea defense which has improved and actually reversed the trend of erosion at Totope, this community was also on the verge of being submerged or lost. The view of the local people is supported by secondary data which shows that sea levels have been rising in Ada.

5.2.1 Perceptions of Non-Climatic Drivers of Flooding

Sand winning for building purposes, channelization of beach, siltation of the beach and blocking of river channels are not the causes of flooding in spite of the admission of the fact that sand winning is a prevalent activity. The respondents are of the view that sand from the beach is a gift from god which they have to use for themselves. To buy sand elsewhere to put up their buildings may not be a wise thing to do besides "*the sand is used to build to save cost*". In Goi, there were about 5,000 pieces of brick which had been molded for construction along the beach at the time of fieldwork. There were also a number of houses being constructed with sand from the beach at different stages of completion. All the new settlements that were springing up around the communities used sand from the beach. The implication is that as the area of sand mining extends, the beach profile is disturbed and vegetation along the beach is eroded. Most of soil around coconut trees are eroded. The grass areas along the beach are removed.

Traditional authorities in some of the communities lamented about the increasing spate of sand mining in the communities and the fact that several attempts to control the rate of sand mining have not yielded positive response. Residents continue to make brick from the beach and because the entire community is “one family”, even if you arrest or summon somebody, family members come to plead. “*How stringent can you be?*” asked one of the chiefs.

5.3 Impact of Flooding

The nature and extent of impact of flooding varies according to location of residents, and in most cases, the type of flood. That notwithstanding flooding affects residents of Ada in both direct and indirect ways.

Directly, flooding affects people who live closest to the sea and thus are affected by the effects of the combination of wave heights and wind speeds, erosion and elevation. The residents who live by the sea on a daily basis experience flooding from normal waves. These are considered ‘normal’ in the sense that they have lived with such condition for some time and have become use to it. They move in and out of their homes during high tides and return when the tide is low. Those along the river banks are also affected by river floods on the daily basis as they make adjustments to the effects of the floods. Residents of Azizanya are aware that the community floods in the morning and in the evening. They ensure that there is nothing on the floor in their rooms. Those who fry fish and use fire are all aware so the construction of fire places also takes into consideration the flood situation. Rainfall affects all the communities and the impact of rainfall is compounded by the fact that there are inadequate drainage systems in the communities. Flooding affects daily activities as people are unable to move about easily. Schools are forced close down. Clinics in the communities sometimes get overwhelmed by cased of cholera outbreak. Some of the canoes are washed away by tidal floods so fishermen have to protect their canoes by keeping a close watch on the intensity of the floods. When the communities become flooded, activities come to a halt.

Indirectly, flooding affects adjoining communities who become recipients of the migrants from flood prone areas. Where receiving communities are not generous enough, this leads to tensions. For example, the people of Totope who had considered moving to Aminapaah a location near the community are unable to move because the receiving community is not ready as the ownership of their land is in dispute. Shortage of land is a serious issue in Ada as residents continue to be pushed back by coastal floods and erosion.

Flooding is a daily occurrence. The floods that are "extraordinary" are the ones that receive media attention. It is in these times that people from all places come to visit. It is also "*the time when our politicians come around and appear to be concerned but when everything dies off, nobody would mind you*" (Opinion Leader at Akplabanya, from field notes). Normal high tides get to our homes every day. The main impact of flooding includes temporary removal from home, loss of personal belongings, restriction of movement, disruption, disease and filth in the community.

Health officials in Sege, the district capital of Ada West reported that in the past every time there was flooding there was cholera outbreak in the communities. Even though the incidence of cholera has reduced significantly according to the health officials, the major problem now as far as flooding is concerned is Malaria and Typhoid due to the insanitary conditions that prevail in the communities. In Lolonya (one of the study communities) for instance, it was observed from the study that open defecation in some of the flood plains was prevalent. River Akplabanya is also silted with refuse as people try to reclaim portions of the river for activities including fish smoking and residential structures. There are stagnant waters that stays in some of the communities (Akplabanya and Goi) whenever communities flood. A lot of malaria cases are reported to the health facilities in Ada during flood periods. Even though measures such as public education and distribution of mosquito nets are being executed, attitude remains the biggest challenge to dealing with diseases associated with flooding. It is the belief of some of the community members that the sea has a way purifying the communities and itself so the filth that is generated would be 'cleaned' by the sea. Some community residents explained that it is the reason why everything that the sea dislikes will be eventually be rejected. Health authorities are under pressure to deliver quality healthcare during the flood period but adopting hygienic practices remains a major challenge in the communities along the coast. Another challenge associated with the delivery of quality healthcare in inadequate funding for the health centers.

5.4 Gender Perspective of Flooding

The extent to which flooding affects people vary according to gender. Men, women, children, disabled and aged experience flood and its impacts in different ways. This consistent with Rakib et al., (2017) who observed that the effects of floods vary across gender. The type of flood and the location of the women determine the impact in both scale and substance. Flooding contaminates the river water which is the main source of water for domestic chores. Women along the banks of the river use water for cooking, bathing and sometimes for drinking. During flooding either from the sea or the river, the rivers either becomes saline (if flooding is caused by tidal waves) or dirty if flooding is caused by heavy rains with rubbish and plastics. When this happens, women are unable to use water from the river. It is difficult to get out from their homes to get water because the entire place is flooded and unsafe. It is worse for women on the island as they become restricted to the island with very limited options of sources of water. To avoid the unpleasant situation of water shortage women on the island have huge receptacles which they use to store water as they cannot predict when flooding (storm surge, riverine or rainfall) will occur.

Flooding prevents women in the communities from pursuing their business. Fishmongers are not able to dry and smoke fish. All their firewood gets soaked in water which makes lighting of fire difficult. They are prevented from being able to work to feed their families. Those who trade are unable to move to sell their produce. Some women lamented that fishermen are unable to go to sea to bring them fish to smoke because during flooding fishermen are not able to go fishing for several days. This is especially the case when flooding is caused by storm surge. This limits the supply of fish. Women who own the fish mongering business employ a lot of young women whose livelihoods depend on the fish business. When there is no fish mongering activity there is no income for the young ladies who have to depend on income from fish mongering for their future. In a focus group discussion with some of the young women who worked with fishmongers, most of them depend on income from these activities (assisting fishmongers) to buy cookware and other household items in preparation for marriage. Those who are married and have children use proceeds from their work to pay for school fees of their children and also support their husbands to provide for the home.

Some of the women participants in the focus group discussion explained the danger flooding poses to their children. This account by one of the participants captures the sentiment vividly;

> *"…one day I was in the room with my child sleeping at night on the floor. Suddenly water rushed into the room while my child was on the floor. If I hadn't been fast enough, my child would have died".*

Mothers take extreme caution to prevent children from being affected by floods. Babies are carried by their mothers to ensure they are also safe. Children are unable to play on the floor. Children's mobility is restricted.

5.5 Flood Response

Responses to flooding are at different scales. The household level, the community level through the chiefs and elders of the communities and the institutional level through the district assembly and other organizations.

5.5.1 Household Response to Flooding

At the household level people construct barriers to prevent water from the getting into the homes. While these barriers get inundated during heavy floods, they are able to reduce the flow of water into their homes during high tides. These measures are effective when the extent of flooding is minor and moderate floods (Maddox, 2014). During major flooding, these measures are unable to contain the floods. The respite is that major flooding does not occur frequently.

Households also ensure that nothing is kept on the floor especially valuable items like electrical appliances. Almost every item in the room is elevated above the floor due to uncertainty of when floods will set in. This strategy has become common among households along the beach and residents along the river bank.

5.5.2 Community Response to Flooding

At the community level there are varied responses to flooding. In severe cases of flooding, the community mobilizes to create channels of flow for the water to go into the sea. Depending on the cause of flooding, community members mobilize to solve the problem if it is within their capability. For instance, when it was observed that one of the causes of flooding in Wokumagbe was due to the construction of a salt production facility which led to the diversion of water way, they approached the developer for discussions to reconstruct a proper diversion. For instance, a water channel that was blocked by a salt production factory was cleared by the youth in the community by mobilizing themselves. There are instances where the announcer of the town informs community members of impending floods to enable them to prepare for the floods. There are key persons in the town who inform of possible flooding. As information reaches these persons, they hoist a red flag to signal to fishermen that there is danger in the coming days. It enables them to secure their boats and canoes to reduce losses. This shows that local people have interesting adaptive ways of adapting to situations at the community level. In the absence of warning systems local people through their mechanisms are able to adapt to conditions.

5.5.3 Institutional Response to Flooding

At the institutional level National Disaster Management Organization (NADMO) is responding for coordinating emergency disaster response. NADMO has offices in both Ada East and Ada West and coordinates flood response activities such as evacuation of affected people from flooded areas. NADMO supports flood victims with relief items such as mattresses, blankets, food items etc. The Ghana Meteorological Agency also assists in alerting the community members of impending floods.

Before floods, residents are pre-informed by the meteorological agency. Some of the fishermen have been trained in the community to identify turbulent waters or weather. When they suspect flooding community members are informed through particular persons in the communities.

5.5.4 Migration as a response to flooding

Migration is one of the responses to flooding in Ada. Migration occurs at three levels. The first level of migration is retreating furthers away from the flood plains where people relocate from areas close to the sea and put up structures inland. At the second level of migration residents relocate to adjoining communities to resettle with relatives until the abatement of flood or they are look for alternative place of settlement. For instance, some of the families whose homes have been devastated by erosion have sought refuge in Sege where land has been allocated to them. While it may appear close and the variations in culture may not be significant, tracing and connecting back by younger generations is difficult as their family homes are lost. The third level of migration is the category of people who have complete left Ada and settle in areas such as Tema and Ashaiman. For some of these people, due to the proximity to Ada, they only visit on festive occasions. Reference is made to the fact that their homes have long been "swallowed" by the sea. There are those who have moved to settle in Sege due to erosion but come to the coast to perform fishing activities daily and return home. Figure 33 is the remnant of a house which use to occupy by a family in Wokumagbe. The house has been completely taken over by the sea and the people have been forced to move inward.

5.6 Flood Mitigation

One of the measures that have been introduces to reduce flooding in Ada is the construction of the sea defense (construction of 15 groynes and beach nourishment and protective barriers) by the government. The views regarding the sea defense is mixed. In Totope, one of the key informants narrates how about 300 meters of land has been recovered as a result of the construction of the sea defense. He adds that due to the improvement of the situation as far as erosion is concerned, several people are returning to the area. He notes that it is one of the best things that have been done for the community in recent times. In sharp contrast to this flooding mitigation measure, the Chief of Azizanya retorted that

> "*The construction of the sea defense is the most wicked thing ever. It has shifted the estuary close to us. Now, during high tides, the sea disturbs the community and has eroded all the land. The construction was done but not properly completed. We are losing our places. Yes,*

the engineers have done their work but if they consulted us, we would have been able to assist with some ideas."

In his view, the construction of the sea defense has aggravated the flood situation as it has intensified the rate of erosion. As can be seen from the quotation, there are concerns about local participation in decisions to curb flooding. Local people do not think the construction of the groynes was not properly done. In their view, even though they may not be engineers, they can tell that the construction was no done properly because the problem has just been transferred to Azizakpe. Since the construction of the groynes, erosion around Azizakpe has worsened and led to loss of land and erosion of vegetation (mangroves). Investigation into the alternative suggestions about what could have made the construction of the groynes more effective yielded no answers. Many people have left the community as a result of the persistent floods in the area. The VRA confirms this when they compare the Keta sea defense to the Ada sea defense. The estimated effectiveness of the Ada sea defense is 45% according the VRA because there are communities that still suffer from severe flooding. This is supported by Owusu-Daaku, (2012) who observed that residents living behind the Ada sea defense are not satisfied with the structure as the sea was able to rise above the wall at high tide and flood their homes

Another flood mitigation measure is dredging of the river. Dredging has reduced flooding along the coast by about 30-40% according to the Volta River Authority Dredging Unit (Source, Field notes). VRA attributes the cause of flooding around the estuary to low elevation of the area and increase water level of the sea and river. This is also supported by an opinion leader of the Azizanya who said that the people of Kewunor and Azizanya settled at their current location which was not designated as a settlement. The entire area was reclaimed by VRA with dredged sand from the river. The least rise in sea tides leads to flooding along the coastal communities. Dredging is done often as a preventive activity to avoid flooding.

5.7 Flood as nature's contribution to people

Floods have been reeling havoc to many people in Ada. Floods have evicted people from their homes destroyed properties and robbed people of their heritage in various ways (Agricultural lands 9.20%; historical sites 2.60%; cemeteries 5.80%; land 1.20%). However, sometimes when flooding becomes a positive contribution to some of the community members as water that is left behind after flooding breeds fish which the communities harvest. Some of the fish they harvest from the water are Tilapia, Mud fish and sometimes crabs. It is worth noting that the type of fish that is harvested depends on the type of flood. Because the water can stay quite long after the floods, it becomes a source of fish for the people during the leaning fishing season. Children swim in the water sometimes. This perspective of flooding is consistent with the definition of Diaz (2018) that nature's contribution both positive and negative.

5.7.1 Implications of Missing Places and Spaces

Many cultural ecosystems services have been lost in Ada. Significant among these cultural ecosystems is place. Places have been lost in Ada leading to loss of many years of lived experiences by residents who are unable to connect to the past. Cemeteries where people visit to commune with their dead relatives have been lost. An elderly woman in her nineties retorted "*one day the sea will wash me away just like all the others*". These comments were made with lots of emotions and apprehensions about the future. All the communities involved in the study have lost cemeteries.

Recreational areas where people played when they were growing up have been lost. Residents talked about this with nostalgia. A swimming pond called *Obl3naa y3d3* and a football park called *the black field* have been lost. Shrines which people had in the communities have been washed away including the Wichi Shrine. As noted by Dickinson (2013), place such as shrines, cemeteries and swimming ponds are physical places that people have experienced and attached meaning to. If sense of place is acquired through the physical characteristics of one's environment as observed by Steadman (2003) then loss of the physical environment in Ada means that there has been significant loss of place as the physical characteristics of the ecosystems have changed over time due to flooding.

5.8 Ecosystems and Culture

There is a dynamic relationship between ecosystems and culture heritage and social interactions as observed by Vasiljevic & Gavrilovic (2019). The lives of the people are intertwined with the ecosystems in their environment. Customs and tradition are evolved by people around ecosystems and have been affected by flooding.

5.8.1 **Taboos**

Among the people of Ada, there are several taboos related to the ecosystems in the area. Taboos have ensured that people of the communities are minded about the impact of human activities on ecosystem in particular and the environment in general. Ecosystem related taboos include the fact that women are not allowed to swim in the Ada River. The idea is to free the river from contamination. The river is a key source of livelihood and water from river is used for cooking and other household activities as sometimes people drink directly from the river. It is interesting to note that while young girls can swim, older women above puberty are not allowed to swim. It is believed that because older women menstruate, and one may not be able to determine when menstruating women will enter the river then the best approach is to prohibit women generally from swimming in the river. This represents a form of marginalization that leads to stereotyping of women. For many of the women in the communities it has become a normal as they do not imagine swimming in the river. This barring of women from swimming in the river has serious implication for gender inclusiveness at the community level. Women are however allowed to swim in the sea since it the belief of the people that the sea can cleanse itself of any form of contamination.

Women in the communities have gotten use to this taboo to the extent that hardly would you find women bathing in the river. The women respondents spoken to were not bothered about the taboo because they held the view that if you are a woman and you go and bath in the river, you are likely to be seen by men and this may not be too good especially if you are a man. Most of the women who live around the river have gotten use to the taboo. It was observed that white women irrespective of their age are exempted from this taboo because they are considered temporary residents. This discriminatory practice raises questions about the relevance of the taboo because white women can also contaminate the river.

Another taboo that is held important among the Azizanya is the taboo that bars people from sending black utensils to the riverside to wash because it believed that it will wash the sand away. This taboo is still practiced among the people even as the community continues to be threaten be flooding and erosion.

Before the celebration of the Asafotufiam festival, community members sweep the entire community, collect the rubbish and dump them into the sea. By the sweeping the entire community, it is believed that they have collected all their ailment or sickness and dumping into the sea signifies that purification. This is also based on the belief that the sea has the capacity to purify itself.

5.8.2 Festivals

Another important aspect of culture which is intertwined with ecosystem is the festival of the people. The main festival of the people of Ada is the Asafotufiam Festival (Firing of the Musketry). The festival is held annually to mark their escape from Lolovor and the Akohue became their hiding place from where they fired musketry towards their enemies. Prior to the celebration of the festival, the elders of the town visit the Anyamam where the ancestral home of the Ada is located. It is located in the Akohue Forest. The forest is considered significant in the lives of the Ada people. Originally, there were four clans in Ada until the Akans and Ga came to join the indigenes to make the clan 7. The forest has seven trees in the middle representing the seven clans of Ada. Rituals are performed in the forest prior to the celebration of the festival to venerate their ancestors and to ask for blessing in the coming year. This forest is been encroached upon by farms and buildings as people loose livelihoods from fishing and loss of homes.

5.8.3 Social norms

There are several ways in which the ways of life of the people are connected to the ecosystems in the area. Some of these connections are obvious to see but other connections manifest in ways that are obscure. Because of the abundance of coconut vegetation, the people of Wokumagbe will normally welcome you with a coconut juice as one of the customs of the community. Similarly, most of the traditional houses have woven coconut leaves in front of their houses. The stem of the coconut trees is used as beams for their building houses. Sometimes, the locals tie swings between the trees with the view to relaxing when temperatures are high. Collection of oyster shells from the river is also a common feature in Ada when the women and collect and sell them to paint manufacturers.

Another important feature of the communities is crab hunting. Crab hunting is a very prevalent activity among people living in Ada, especially among resident along the river. Crab is a delicacy in Ada and form part of the daily diet of the people. Crab is mostly harvested by the men along the river and sold by the women at the marketplaces.

5.8.4 Naming of Towns

It was observed that the names of most of the towns have relationship with some ecosystems. For instance, the name "Lolonya" which is one of the communities in Ada West is derived from the name of a river. Lolonya therefore means the bank of river Lolo. Again, "akplabanya" is also derived from the name akplaba, who is believed to be a river god. "akplabanya" therefore means "banks of the akplaba river". "kewunor" is also another community that derives its name from the fact that it is located on a sandy beach. "kewu" mean sand and "nor" means on. "Kewunor" therefore mean "on the sand". Finally, the azizanya community has an interesting origin to its name. The term "azizanya" is derived from two words, "Aziza" which mean "estuary" and "nya" which as means "mouth". Literally therefore, the term Azizanya means "the mouth of the estuary". Azizanya therefore means the banks of the estuary. The above shows how important ecosystems are in the name of towns in the communities.

5.9 Loss of Cultural Ecosystems and the Sustainable Development Goals

As observed by Arico (2005) 60% degradation of ecosystems will have a significant effect on cultural ecosystem services even though the scale is unknown. Cultural ecosystems are important components of sustainable development goals. Indeed, poor cultural ecosystems services or negative contribution of nature to people has significant implications for the realization of sustainable development goals. This section links the status of cultural ecosystems in Ada to sustainable development goals.

As has been noted in the literature review, a critical review of the SDG targets will reveal that cultural ecosystems services are linked to SDGs at the levels of goals and targets. SDG goal eleven aims at achieving sustainable communities and cities. At the rate of erosion and flooding, it is certain to assume that the communities in this study are vulnerable. Unless remedial actions are taken, a community like Azizakpe may not exist. Until recently when the sea defense was constructed, a community like Totope has become a "ghost town" as most of the community member has migrated to other town and communities. Some of the residents had migrated to Sege and Big Ada. Kewunor and Azizanya communities have been retreating over an approximate distance of two kilometers. The current location is also not safe as there is occurrence of daily floods in the communities. If the aims of achieving sustainable communities are to be realized, then frantic efforts must go in stemming flooding in Ada.

Closely related to sustainable communities is Hunger and poverty. Elimination of poverty is one of the prevalent challenges that confront humanity according to UNDP and the goal of eradicating same is the primary objective of the sustainable development agenda. As people continue to be forcefully evicted from their places the likelihood of being exposed to further impoverishment is high. Already, some of the people in Ada have lost their livelihoods and assets like family homes, canoes and outboard motors. Unless some policy intervention measures are put in place, the circumstances of many more people would be worse as they are rendered further impoverished.

Another important goal which is being pursued by world leaders is the goal of good health and well-being which is SDG Three. One of the immediate consequences of flooding in Ada is deteriorate health condition among the people. According to the health authorities in the districts, due to poor hygiene practices among the residents such as open defecation and indiscriminate dumping, flooding always results in the outbreak of cholera in the communities. Flooding also leaves a lot of water around that becomes breeding grounds for mosquitoes and increases malaria incidence. The outbreaks of cholera and malaria cases are the two direct ways in which the objective of good health is impacted. Indirectly, community members who are sick are not able to attend clinic which worsens their predicament. Well-being refers to the condition of a person or a community. Good well-being means that the community has a positive feeling of life satisfaction good physical and mental health. To live in fear of flooding and fear of loss of place does not engender positive feeling among residents. Old people in the communities are apprehensive of graves being wash away and possibility of same happening to them. The chief and elders of the Azizakpe are sure that sooner than later the community will not exist unless something is done about the situation. Mothers are always alert because leaving their children on the flooring might mean exposing them to floods. This is because floods do not announce their coming.

The deterioration of cultural ecosystems services has implication for SDG target 8.9 and 12.b which aims at promoting sustainable tourism, local culture and products. Ada had beautiful beaches and a nice estuary which attracted a lot of local and foreign tourism. The beaches of Ada were enjoyed by many people according to residents. Due to flooding and erosion of sandy beaches people no longer use the beach as they did in the past. Again, due to migration from the beach front, many people have encroached on the Ramsar site. This has reduced the number of birds that visited the Ramsar site and reduce patronage. The reduction in sandy beaches has also affected turtles as they lay their eggs in the beach sand. This has impacted turtle population in Ada.

SDG target 11.4 and 4.7 also make reference to cultural diversity. Cultural diversity refers to the variety of cultural norms, practices and ethnic grouping with a society. Throughout the study, the most important element of cultural identify under threat is the Okohue forest which is the symbol of identity of the Ada people. This forest has been reduced and it is still being encroached upon. It is becoming apparent that the forest will be lost and the practice of visiting the forest prior to Asafotufiam might take another form. It will affect cultural diversity and be a setback for sustainability agenda.

It is clear from the above discussions that cultural ecosystems services are linked to the sustainable development goals is many ways. The realization of these goals in Ghana must therefore among others consider the status of cultural ecosystems services in Ada in particular and the country in general.

5.10 Management of Cultural Ecosystem Service using the Bayesian Model as a Decision Support Tool

The model predicts that an increase in the states of the drivers of flooding will lead to a severe impact on cultural ecosystem services in Ada. There will be additional loss of place in Azizakpe or a complete loss of the community while place at Lolonya will be severely inundated. An increase in anthropogenic drivers of flooding is less likely to have significant impact on flooding compared to an increase in climatic drivers. The model shows that climatic drivers present severe threats to the coastal dwellers of Ada East and West Districts. The need for policy intervention is imminent as the model predicts that adequate policy intervention can go a long way to ameliorating the condition of cultural ecosystems services. Evidence from the field showed that policy intervention like the construction of sea defense can have positive impact on the cultural ecosystem services. In Totope, the construction of the sea defense in Ada has led to accretion of about 200 meters of land. Inhabitants who had migrated due to the onslaught of flooding are returning. In contrast, the people of Azizanya have lamented about the negative impact of the Ada sea defense on the community. Erosion and flooding have intensified since the construction of the sea defense.

The mangroves have all been lost. The inconsistency in the outcome of the policy intervention shows that interventions must be comprehensive with adequate feasibility studies.

The results from the study showed that apply the Bayesian network model to understanding the future implication for cultural ecosystems services in Ada will be useful especially of cultural ecosystem status is to be closely monitored. The results further showed the flooding in Ada is a geomorphological and climatic phenomenon. Anthropogenic factors do not contribute much to flooding although there several anthropogenic activities that needs to be curbed. Efforts to reduce flooding in Ada should gear towards dealing with the geomorphic feature of the landscape and climate action. Because the climatic drivers are a global phenomenon, local measure will have to be aimed at further reducing the anthropogenic drivers and engineering the landscape and seascape.

5.11 Summary of discussions

5.11.1 **What are the Drivers of Flooding in Ada?**

The majority (98%) of respondents indicated flooding is a serious problem in Ada. Three main types of floods were identified. These are coastal floods which is flooding from the sea; pluvial flood which is flooding from surface runoff and fluvial floods which is flooding from the Volta river. Coastal floods have been observed to be the most prevalent and devastating type occurring about five times a year between May and August and September and October.

Perceived drivers of flooding in Ada were classified into anthropogenic, climatic and geomorphic drivers with climatic being the predominant. The climatic drivers (wind and wave, sea level rise and rainfall) are exacerbated by the geomorphic features of the study area which compounded flooding. Anthropogenic drivers such as population, sand winning and land use change although recorded in the study area, do not significantly influence flooding, as seen by both primary and secondary data.

Community members generally do not receive prior information before flooding. During flooding, the main institution that coordinates emergency response is the National Disaster Management Organisation (NADMO). To a lesser extent, emergency response includes the District Assembly and Office of the Member of Parliament. Some community members also assist during flooding.

The role of community members cannot be over emphasised because of the way they assist one another in times of flood. Community members help by providing vital information that contributes to successful evacuation.

5.11.2 To what extent does the perception of drivers of flooding Compare with measurement of drivers of flooding in Ada?

Compared to data obtained from Ghana Meteorological Agency, Wave and Wind data and tidal data over the period 1985 to 2017, respondents' perception of the drivers of flooding were confirmed. Remotely sensed data which was analysed using GIS also confirmed that there has been significant (-3.84) erosion of shoreline and this also contributes to flooding in Ada. Structural Equation Model used in the study also showed significant path relationship between the Flooding and the drivers. The path analysis showed that climatic factors are the main drivers of flooding.

5.11.3 What is the status of ecosystems in Ada?

Ecosystems in Ada include the sea, sandy beaches, forests, marshes, river, lagoon, mangroves and wildlife such as turtles, different species of snakes, crocodiles, grassland and land. Communities in Ada depend on ecosystem services for their existence. In all, twelve different types of ecosystems and 15 cultural ecosystem services were identified

One of the important categories of ecosystems services that affect the lives of the people in Ada is the cultural service. Place, recreation and aesthetic were the three main cultural ecosystems that were considered very important. In addition, cultural livelihood, also emerged as a novel cultural ecosystem service and was explored further in the study. Cultural livelihood refers to the satisfaction people derive from pursuing what appears to be subsistence activities. This new cultural ecosystem service expands the typologies of cultural ecosystem services.

Place refers to the spaces people occupy, and which defines their identity is an important cultural ecosystem service. Some of the Places identified included Family homes, Cemeteries, Schools, Shrines, Churches, Recreational areas, etc. Aesthetic cultural ecosystems were also identified as an important ecosystem that manifested through the beauty of the landscape, use of the beach from and the sandy beaches which people perceived as beautiful. The third cultural ecosystem service in Ada that emerged from the study is recreation. Recreation was important to the extent that people previously visited the beach to swim and relax in the sand. The coconut vegetation also provided shade for relaxation. Coconut trees also provided shade for fishermen when they were mending their nets. A fourth cultural ecosystem service that was discovered and subsequently conceptualised in the study was Cultural Livelihood. Cultural livelihood ecosystem service represents the non-subsistence aspects of livelihood activities which brings people satisfaction and fulfilment. It is driven by those traditional occupations that have been handed over for generations.

5.11.4 What are the implications of flooding on Cultural Ecosystem Services?

Between 1985 and 2017, flooding has affected each of the main cultural ecosystem services in various ways. The principal cultural ecosystem that has been affected by flooding is Place which showed that several places such as homes, cemeteries and family lands, have been lost in Ada. Another important cultural ecosystem service that has been affected is recreation. Due to flooding, groynes have been constructed along the beach making is unattractive for recreational activities. Surface runoff also carries along plastic waste to the beach which litters the beach. Most of the vegetation along the beach has also been lost. Aesthetic cultural ecosystem service has also been affected by flooding as the entire landscape has changed due to flooding prevention measures. Cultural livelihood which is an experience people derive from participating in livelihood activities is also threatened as floods evict people.

5.12 To what Extent can the Bayesian Network Model be used as a Decision Support Tools to Management the Future Implications of Coastal Flooding?

The Bayesian network model can be an important tool to support decision making about the future implication of flooding in Ada. Secondary data and expert opinions which were imputed into the model showed that changes in climatic drivers can have implication of flooding in positive and negative ways. An increase in climatic drivers will worsen flooding and the state cultural ecosystems services i.e. place, aesthetics, recreation and cultural livelihood will be impacted. Many residents will be denied of vital cultural ecosystem services. Comparison of the impact of anthropogenic drivers compared to the impact of climatic drivers also showed that impact of climatic drivers on cultural ecosystems will be more than the impact of deteriorating anthropogenic drivers.

CHAPTER SIX

6. Summary, Conclusion and Recommendations

6.1 Introduction

Based on the extent of environmental changes that have been recorded globally and the coastal environmental changes that are also being experienced around the world, the study set out to analyse the interlinkages between coastal flooding and cultural ecosystem services in Ada. More specifically, the study aimed at identifying the drivers of flooding and to understand the relationships among the variables that drive flooding in Ada. The study also set out to identify the ecosystems in Ada and assess the status of cultural ecosystem services in Ada. Finally, the study analysed the extent to which the Bayesian network model could be used as a decision support tool to understand the future implication of flooding in cultural ecosystems services in Ada.

6.2 Significance of the study

The prevalence of flooding in Ada due to its peculiar location within major water bodies i.e. Songhor lagoon, Volta river and the sea has been elucidated in this study. Understanding the impact of flooding on residents, ecosystems and cultural ecosystem services is an important step towards policy intervention. The significance of the study can also be viewed from several perspectives.

Firstly, the comparison between perception of drivers of flooding and the measured drivers validates local perceptions of flooding. It reveals how local people in their own way understand the drivers of flooding at the local level. Local perceptions are important in issues that concern them.

Secondly, the study brings into focus the extent of impact of coastal flooding and its implications for cultural ecosystem services by documenting critical cultural ecosystem services that have been affected by flooding. It provides a comprehensive inventory of ecosystems and cultural ecosystems in Ada.

Thirdly, the application of the Bayesian network to understand the future implication of flooding in Ada has demonstrated how effective the model can be as a decision support tool in the management of coastal flooding and environmental resource management in general.

6.3 Contribution to knowledge

In terms of contribution to knowledge, the study adds to the growing body of literature that exists in the area on cultural ecosystem services and coastal flooding, erosion and submergence. As noted in the literature review, the subject of cultural ecosystems has not received significant attention among researcher and policy makers until recently.

Furthermore, the identification of cultural livelihood as a new cultural ecosystems service further expands the suite of cultural ecosystems services that has been developed and identified. The study reveals that perhaps there are varied cultural ecosystems that are yet to be discovered by researchers.

The application of the BN model to predict the future implications of coastal flooding and erosion on cultural ecosystems corroborates the importance of probabilistic models in environmental decision-making.

The study serves as a basis for further research in the area of coastal flooding, submergence and cultural ecosystems services

6.4 Limitations of the study

The empirical findings reported in this study should be considered in the context of some limitations. Firstly, access to relevant data was a challenge due to the inability of some institutions to provide data. Data on the incidence coastal flooding and impact on residents was inadequate. In situations where data was available, there were extensive gaps. Secondly, inadequate funding of the study reduced the time that was spent in the field and limited the number of communities that could be study. Island communities that were further away could not be included in the study. Time constraint was another limitation to the study that is worth mentioning because the study had definite timelines that could not be overlooked. Time constraint meant that the scope of the study needed to be defined to enable completion on schedule. In the context of Ghana, not much studies have been carried out in the area of coastal flooding and its relationship with cultural ecosystem services which limited perspectives. Finally, the sample size used in the study could have been larger to increase the validity of the findings.

These limitations notwithstanding, steps were taken to ensure that the results obtained from the study can be relied upon. In terms of the sample size, scientific, representative and acceptable method for determining sample size was used in the study. Communities were carefully selected to ensure that they could represent the phenomenon being studied. Finally, due to funding constraint, extensive work had to be done with the limited time frame. This reduced the cost of field.

6.5 Recommendations

Based on the study, the following recommendations are proposed. The recommendations are categorised into two; policy recommendation and research commendations.

6.5.1 Policy Recommendation

The main drivers of flooding climatic and therefore environmental, although efforts from local residents can help reduce the impacts. A three-tier recommendation is offered to ameliorate the impact of flooding- transnational, national and local.

At the international level, efforts to stem the tide of climate change must be vigorously pursued as the forces behind some of the climatic drivers are transboundary in nature. At global, regional, sub-regional and national levels work towards climate emissions reduction targets must be accelerated to ensure that Ghana's commitment to global emissions reductions are achieved.

International and regional agreements such as the Sendai Framework should place more emphasis on the implications of disasters such as coastal flooding on cultural services. The Hyogo Framework for instance aimed at substantial reduction of disaster losses in lives and in the social, economic and environmental assets of communities and countries. What cultural services constitute communities' assets, is not given prominence.

At the national level, the National Disaster Management Plan must be reviewed to elaborate on the community risk of geological and hydro-meteorological disasters such as the impact of coastal flooding on cultural ecosystems services. In the disaster management model of the National Disaster Management Organisation, mention is made of community risk without providing details on areas of communities that are affected. Coastal communities flood risk mapping for instance would be necessary for the communities in Ada.

Institutional capacity of the National Disaster Management Organisation (NADMO) needs to be strengthened to collect and store data on the incidence of disasters in Ada but also across the country. The study found that comprehensive data on the occurrence of flooding, impact on communities and the dynamics of disasters are inadequate. At the district levels, NADMO needs to be resourced with logistics to enable it function more effectively.

Place is a critical cultural ecosystem services affected significantly by coastal flooding. Measure to protect the beach to reduce the rate of erosion is needed. The coastal defense system should be assessed and evaluated to determine its effectiveness or its impact on other communities. At the local level, several measures can be put in place to ensure that the impact of flooding is minimized.

- Provision of landing beaches in designated communities to assure cultural livelihoods and protect fishing heritage.
- To minimize the impact of flooding, extensive education should be carried out in various communities.
- Development of an early warning system for the communities can go a long way to reduce the impact of flooding in the communities.

Based on the conclusions from the study, the following recommendations are proposed. The recommendations are categorised into two; policy recommendation and research commendations.

6.5.2 **Research Recommendations**

The concept of cultural livelihood as an ecosystem service needs to be further explored to understand the various perspectives. Detailed analyses of the concept are beyond the scope of this study. In addition, the valuation of cultural livelihood as cultural ecosystem service as is the case with other cultural ecosystem service must be explored.

The rate of loss of place along the Ada coast is having a devastating effect on residents. It will be important to invest some ideas into possible ways of reducing the trend. Perhaps research in the area of ecosystem-based approach to erosion reduction can reveal interesting results. Research into the impact of coastal flooding on the Songhor Ramsar site is also recommended.

Research has to be conducted in the area of alternative livelihood options for local people as many of the residents are losing their livelihoods from fishing and fish mongering. Apart from fishing, residents also mine salt. The creation of channels for sea water to flow to salt pans is also affecting cultivation of crops as alternative livelihoods. Perhaps, building of greenhouse vertical farms on racks can contribute to ensuring that residents continue to farm.

The research department of NADMO must be strengthened to enable to obtain data and stored for public use. In this regard, advanced information systems can be deployed to ensure that continuous data is collected. This will help in observing the trends in flood disasters and provide significant basis for policy-decision making.

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Appendix 1: Survey instrument

HOUSEHOLD QUESTIONNAIRE SURVEY

INSTITUTE FOR ENVIRONMENT AND SANITATION STUDIES

UNIVERSITY OF GHANA, LEGON

THESIS TITLE:

ANALYSES OF THE INTERLINKAGES BETWEEN COASTAL ENVIRONMENTAL CHANGE AND CULTURAL ECOSYSTEM SERVICES IN ADA, GHANA

HOUSEHOLD SURVEY

	Name or Description
Community	
Household No.	
Structure No.	
District	
Region	
INTERVIEWER	
Name	
Signature	
Date	

This survey is being administered by Stephen Babson, a PhD Student at the Institute of Environment and Sanitation Studies of the University of Ghana, Legon. All enquires may be directed to:

Mr. Stephen Babson

P. O. Box AN 18755, Accra-North

Tel: 0242050501

Email: stephenkofibabson@gmail.com

Dear Respondent,

The objective of this questionnaire is to understand activities that cause flooding in Ada and its impact on the cultural benefits that are realized from the various ecosystem services. It also seeks to identify the ecosystem and some of the potential services in the area and how these have been affected by coastal flooding. Your participation in this study is voluntary (not compulsory) and you may at any time withdraw from the study without any penalty. You or your legal representative will be informed in a timely manner if information becomes available that may be of relevance to your willingness to continue participation or withdraw.

If you have any issues on your rights as a participant you can contact the address below:

Administrator, Ethics Committee for Basic and Applied Sciences
College of Basic and Applied Sciences
University of Ghana
P. O. Box LG 68
Legon – Accra
Tel: + 233 207684121
Email: eoghartey@ug.edu.gh

A1. Name of Household head____

A2. What is the age of the household head? ______________________________________

A3. What is the marital status of the household head?

1. Married ☐
2. Separated ☐
3. Divorced ☐
4. Single ☐
5. Consensual Union ☐
6. Widow ☐
7. Widower ☐
8. Other ☐

A4. What is the gender of the household head ? 1. Male ☐ 2. Female ☐

A5. What is the level of education of the household head?

1. No Education ☐
2. Primary ☐
3. Junior Secondary ☐
4. Vocational ☐
5. Senior Secondary ☐
6. Polytechnic ☐
7. University ☐

A6. Do you have any training? 1. Yes ☐ 2. No ☐

A6a. If yes, please specify____

A7. What is the primary occupation of the household head?

1. Farmer ☐
5. Government worker ☐

☐

2. Fisherman ☐
3. Trader ☐
4. Unemployed ☐
6. Homemaker
7. Salt Mining ☐
8. Other, please specify ☐
9 Don't know ☐

A7A. What is the secondary occupation of the household head?

1. Farmer ☐
2. Fisherman ☐
3. Trader ☐
4. Unemployed ☐
5. Government worker ☐
6. Homemaker ☐
7. Salt Mining ☐
8. Other, Please specify;__________________
9. Don't know? ☐

A7. What is the religious affiliation of the household head?___________________________

A8. What ethnic group do you belong to?____

A9. What is the permanent place of resident of the household head?___________________

A10. How long have you lived in this community?___________________________________

A11. Prior to this place, where did you live?____

A12. Why did you move? ____

A13. Do you own land? 1. Yes ☐ 2. No ☐

A14. Who in the family owns the land? ____

A15. What is the size to land that is owned? __________________Acres / Hectares / Plots

A16. What are the sources of income to the household?

1. Farming ☐
4. Occupation ☐

2. Fishing ☐ 5. Remittances ☐

3. Trading ☐ 6. Salt Mining ☐

7. Other, please specify____________________

Household Assets

A17 Do you or any member of your family own any f the following assets?

No.	Item Description	Does any member of your household own any of these items? 1.Yes	2. No	How of these do you own? 1. Working	2. Not	What was the price? If gift pls indicate GHC0.00
1	Air conditioner					
2	Bicycle					
3	Boat					
4	Camera					
5	Canoes					
6	Car					
7	Computer Accessories					
8	Fan					
9	Food Processor					
10	Freezer					
11	Furniture					
12	Generator					
13	House					
14	Iron (Box)					
15	Iron (Electric)					
16	Jewellery					
17	Land/Plot					
18	Laptop					
19	Microwave oven					
20	Mobile Phone					
21	Motorcylce					
22	Outboard motor/s					
23	Printer					
24	Radio					
25	Record Player					
26	Refridgerator					
27	Satellite Dish					
28	Sewing Machine					
29	Shares					
30	Stove (Electric)					
31	Stove (Gas)					
32	Stove (Kerosene)					
33	TV					
34	Video Player					
35	Washing Machine					
36	Other please specify;					

A18. Do you own the house you live in?

1. Yes ☐ 2. No ☐

A18a. If yes how did you own it?

1. Built yourself ☐ 2. Inherited ☐ 3. Other, please specify________________

A19. Who makes decisions in the house regarding household income? _______________________

SECTION B- Flooding

This section seeks to understand the impact of flooding on cultural ecosystems services. Please provide answers or tick as appropriate.

B1. Have you experienced flooding before? 1. Yes ☐ 2. No ☐

B2. What do think are the causes of flooding in the area?

1= Very Low 2=low 3=Moderate 4=High 5=Very High

	CAUSES OF FLOODING	**1 Very Low**	**2 Low**	**3 Moderate**	**4 High**	**5 Very High**
1	Sand Winning					
2	Erosion					
3	Land use					
4	Vegetation cover					
5	Siltation of wetlands					
6	Industrial activities					
7	Encroaching development (like Harbours)					
8	Sea-level rise					
9	Daily Tidal Movements					
10	Tidal Waves					
11	Rainfall					
12	Riverine floods (Floods from River or stream					
13	Others please specify					

B3. Of the causes of flooding, what do you think are the top three? Please list in order of importance.

No	Causes of Flooding
1	
2	
3	

B4. When do you experience rain flooding? ________________________________

B5. How often do you experience rain flooding around this time of the year? ___________________

B6. Does it affect you personally? 1. Yes ☐ 2. No ☐

B6a If yes, please describe how____

____

____

B7. Does it affect the community? 1. Yes ☐ 2. No ☐

B7a. If yes, please describe how____

____

____

B8. Do you experience tidal floods in this community? ? 1. Yes ☐ 2. No ☐

B8a. If yes, how often do you experience tidal floods?

1. Not Frequent ☐ 2. Somewhat frequent ☐ 3. Not sure ☐ 4. Quite Frequent ☐

5. Very Frequent ☐

B8b. Which part of the community gets flooded? ______________________________________

____

____

____

B9.Do you get you affected? 1. Yes ☐ 2. No ☐

B9a If yes, how do you get affected? ____

____

____

____

B10. Do you experience riverine flooding? 1. Yes ☐ 2. No ☐

B11. How often do you experience riverine floods?

1. Not Frequent ☐ 2. Somewhat frequent ☐ 3. Not sure ☐ 4. Quite Frequent ☐

5. Very Frequent ☐

B12 . Which part of the community gets flooded? ___________________________________

____

____

____

B13. Did you get help during flood events? ? 1. Yes ☐ 2. No ☐

B6a. From whom? ____

B14. Do you receive any advance warning prior to flood event? 1. Yes ☐ 2. No ☐

B14a. If yes from whom?____

B14b. How were you informed?____

B15. What precaution did you take if any?_____________________________________

B16. How effective were the actions you took?

1. Not effective ☐ 2. Somewhat effective ☐ 3. Effective ☐ 4. Quite effective ☐

5. Very Effective ☐

B17. How many times per year do you have flooding anywhere on or adjacent to your property?

1. 0 times a year ☐

2. 1-2 times a year ☐

3. 3-5 times a year ☐

4. 6-10 times a year ☐

B18. Please describe any other impacts or concerns that you have experienced on your property related to flooding. ____

____

____

____

____

B19. Are you likely to relocate from here? 1. Yes ☐ 2. No ☐

B19a If yes, to where?____

B19b Who owns the place?____

B19c If no please explain why?____

B20. What is the total estimated value of loss you suffer from flood annually?

B21 Are there any benefits that you derive from flood? 1. Yes ☐ 2. No ☐

B21a If yes please describe the nature of benefits? ______________________________

____

____

____

B21b. Since when have you been enjoying these benefits? ________________________

B21c. In the light of the benefits do you look forward to flooding? 1. Yes ☐ 2. No ☐

B22. Have any actions been taken to address the flooding situation here? 1. Yes ☐ 2. No ☐

B22a. If yes please specify.____

B22b. If not please explain why____

B22c. How effective was it or were they?

1. Not effective ☐ 2. Somewhat effective ☐ 3. Effective ☐ 4. Quite effective ☐ 5. Very Effective ☐

B23. What do you think can been done to reverse the incidence of flooding?

____

____

____

____

____

____

B24. Do you think the shoreline is eroding? 1. Yes ☐ 2. No ☐

B24a. If yes, what do you think are the causes of this erosion?

____

____

____

B25. Do you think the eroding shoreline contributes to flooding? 1. Yes ☐ 2. No ☐

SECTION C- CULTURAL ECOSYSTEM SERVICES

C1.What are the ecosystems in the area and what cultural benefits do you derive from them?

	ECOSYSTEM CATEGORIES			
No	**Description**	**Please Tick**	**Benefit (Please tick)**	**Describe the nature of benefits (cultural benefits)**
1	Forest systems			
2	Grassland			
3	Marine and Coastal Systems			
4	Mountain			
5	Freshwater Systems			
	Wetlands			
	Rivers			
	Lakes			
6	Dryland Systems			
7	Island Systems			
8	Cultivated Systems			
	Croplands			
	Planted Pastures			
	Agro Forestry			
9	Others please specify			

Adapted from the Millennium Ecosystems Assessment Report (2005)

C2. Following from the above, which of the following cultural benefits do you consider most important?

Cultural Ecosystem Services (Please Tick as Appropriate)	**1 (Not Important at all)**	**2 Not Important**	**3 Important**	**4 Very Important**	**5 Extremely Important**
Place					
Cultural Livelihood					
Recreation					
Others please add					

C3. What are some of the Places that have been lost?

No.	**Item Description**	**Please tick**
1	Churches	
2	Mosques	
3	Schools	
4	Cemeteries	
5	Agricultural lands	
6	Family homes	
7	Recreation areas	
8	Shrines	
9	Communal parks	
10	Historical sites	
11	Markets	

	Others please specify below	
12	Community Centre	
13		
14		
15		
16		
17		
18		

C4. Of the place that have been lost list in order of priority the 1-5, 1 being the most important and 5 being the least important.

1. ____
2. ____
3. ____
4. ____
5. ____

C5. Please describe how the loss of these Places has affected you.

____

____

____

____

____

QUESTIONNAIRE

INSTITUTE OF ENVIRONMENT AND SANITATION STUDIES
UNIVERSITY OF GHANA KEY PERSONNEL INTERVIEW

SURVEY QUESTIONNAIRE KEY INFORMANTS

Dear Respondent,

The objective of this questionnaire is to understand the non-climatic causes of flooding in Ada and its impact on cultural ecosystem services. It also seeks to identify the cultural ecosystem services in the area and how these have been affected by coastal flooding.

1. Name:____

2. Position:____

3. Place of permanent residence: ____
4. How long have you been working in the district? ______________________________
5. How is flooding along the coast?___________________
   ____
   ____
6. What are the sources of flooding along the coast? ____________________________________
7. What in your view are the causes of flooding in the area?_____________________
   ____
   ____
   ____
8. What is the extent of impact of human induced causes of flooding along the coast?
   ____
9. How does flooding affect the people?____
   ____
10. How do you assess the impact of flooding on "place"?________________________
    ____
11. How do you assess the impact of flooding on the beauty of the beach front?
    ____
12. How do you assess the impact of flooding on recreation at the beach front?______________
    ____
13. Please indicate ecosystems and extent of degradation of ecosystem.

Status of Ecosystems		
No	**Name of Ecosystem**	**Extent of Degradation**

		Low	Medium	High

14. Are there any cultural benefits that are derived from these ecosystems and what are they?____
____
15. Are there any linkages between flooding of the coastal and culture services?____________
____
____
16. How does flooding affect your department?
____
____
17. From Policy perspective, what can be done to solve the problem of flooding along the coast?
____
____
____
____
____

18. Is there a coastal management policy of legislation?

____

____

____

Appendix 2: Work plan for data collection

WORK PLAN FOR DATA COLLECTION

Purpose	• This purpose of this work plan is to serve as a guide for consistent administration of data collection for all research assistants and provide information on the entire research process.
Measurements	• Variables use in data collection are a combination of both continuous and discrete
Data requirement	• Quantitative and qualitative data will be required for the study and this would be collected with a questionnaire
Questionnaire Administration	• The primary instrument for data collection is the questionnaire which would be used to collect household interviews to assess the impact of coastal flooding and the interlinkages between coastal flooding and cultural ecosystems services. • Again, Key personnel interviews would be conducted and view from experts would be elicited for the purpose of completing the conditional probability take of the Bayes Network Model. • Field observations would also be conducted to see the extent of erosion and vegetation loss along the Ada coast • with sections of the community to understanding the impact of coastal flooding from a cultural ecosystem perspective
Data Analysis	A combination of data analysis methods will be used. These include; • Statistical Package for Social Sciences (SPSS) will be use to analysis the quantitative aspects of the analysis in terms of the demographics and the relationships between the variables used in the study. • Qualitative analysis such as content analysis and semiotics will be used to analyse the qualitative data.
Field Assistants	• Three (3) research assistants will assist me to administer the questionnaire for the 7-day period.
Duration	• The data collection period is expected to approximately 60 days • The first 7 seven days will involve research assistant conducting household interviews. • The remaining period would be used to collect data on expert views to construct the conditional probability to assess the future impact of coastal flooding in Ada.

Appendix 3: Results of erosion rates from DSAS

Transect Id	TCD	EPR	SCE	NSM	LMS	WLR	WR2	WSE	WCI99	LRR	LR2	LSE	LCI99
1	0	-4.16	94.42	-94.42	-4.33	-4.68	0.98	6.24	44.73	-4.28	0.96	13.87	54.616
2	50	-4.07	92.35	-92.35	-4.04	-4.55	0.98	5.82	41.69	-4.18	0.96	12.93	50.912
3	100	-2.04	90.28	-65.01	-1.95	-3.41	0.85	11.28	10.04	-2.24	0.60	30.21	12.748
4	150	-1.79	88.21	-57.27	-1.89	-3.23	0.83	11.66	10.38	-2.02	0.53	31.77	13.408
5	200	-1.55	86.15	-49.54	-1.73	-3.06	0.80	12.05	10.74	-1.81	0.45	33.38	14.085
6	250	-1.31	84.08	-41.80	-1.55	-2.88	0.77	12.46	11.10	-1.60	0.36	35.01	14.775
7	300	-1.07	82.02	-34.06	-1.37	-2.71	0.73	12.89	11.48	-1.38	0.28	36.68	15.478
8	350	-0.87	79.94	-27.63	-1.23	-2.55	0.70	13.15	11.71	-1.20	0.22	37.82	15.958
9	400	-0.80	77.94	-25.42	-1.19	-2.45	0.69	12.85	11.44	-1.14	0.21	37.24	15.715
10	450	-0.73	76.25	-23.22	-1.15	-2.36	0.69	12.58	11.20	-1.08	0.19	36.81	15.532
11	500	-0.81	74.56	-25.90	-1.23	-2.32	0.71	11.65	10.38	-1.15	0.24	34.34	14.493
12	550	-1.03	72.86	-32.87	-1.37	-2.38	0.76	10.45	9.30	-1.32	0.34	30.53	12.885
13	600	-1.25	71.17	-39.85	-1.49	-2.44	0.81	9.32	8.30	-1.49	0.46	26.84	11.326
14	650	-1.47	74.43	-46.83	-1.74	-2.58	0.85	8.61	7.67	-1.71	0.56	25.28	10.668
15	700	-1.69	83.55	-53.82	-2.16	-2.81	0.87	8.56	7.63	-1.99	0.61	26.53	11.196
16	750	-1.91	88.31	-60.80	-2.46	-2.97	0.89	8.18	7.28	-2.22	0.67	25.94	10.947
17	800	-2.12	93.07	-67.77	-2.75	-3.14	0.91	7.88	7.02	-2.46	0.72	25.48	10.754
18	850	-2.18	96.38	-69.60	-2.89	-3.21	0.91	8.13	7.24	-2.54	0.72	26.49	11.178
19	900	-2.23	98.41	-71.08	-2.92	-3.28	0.91	8.32	7.41	-2.59	0.72	27.06	11.42
20	950	-2.27	100.43	-72.56	-2.92	-3.36	0.91	8.50	7.57	-2.65	0.72	27.63	11.66
21	1000	-2.32	101.95	-74.04	-2.92	-3.42	0.91	8.61	7.67	-2.69	0.72	27.93	11.787

22	1050	-2.26	98.45	-71.97	-2.89	-3.36	0.91	8.49	7.56	-2.60	0.72	27.09	11.433
23	1100	-2.05	94.96	-65.42	-2.59	-3.24	0.89	9.08	8.09	-2.38	0.66	28.28	11.934
24	1150	-1.85	91.46	-58.88	-2.26	-3.13	0.86	9.77	8.70	-2.16	0.60	29.60	12.492
25	1200	-1.64	87.43	-52.34	-1.97	-3.00	0.84	10.49	9.34	-1.94	0.52	30.83	13.008
26	1250	-1.43	80.38	-45.78	-1.66	-2.83	0.80	11.07	9.86	-1.68	0.45	30.97	13.067
27	1300	-1.23	73.34	-39.24	-1.28	-2.65	0.76	11.72	10.44	-1.43	0.37	31.29	13.204
28	1350	-1.02	66.29	-32.70	-1.20	-2.47	0.71	12.47	11.11	-1.18	0.28	31.88	13.453
29	1400	-0.82	62.33	-26.16	-1.24	-2.29	0.65	13.33	11.87	-0.93	0.18	32.74	13.817
30	1450	-0.84	63.19	-26.65	-0.38	-2.20	0.62	13.47	11.99	-0.87	0.17	31.37	13.236
31	1500	-0.90	64.07	-28.85	-0.25	-2.14	0.61	13.61	12.12	-0.85	0.18	30.08	12.694
32	1550	-0.97	64.94	-31.04	-0.28	-2.11	0.59	13.82	12.31	-0.86	0.19	29.64	12.508
33	1600	-0.86	65.81	-27.40	-0.14	-2.06	0.56	14.45	12.87	-0.75	0.14	31.08	13.116
34	1650	-0.71	63.93	-22.54	0.02	-1.95	0.53	14.41	12.83	-0.62	0.10	31.34	13.225
35	1700	-0.65	60.56	-20.77	0.04	-1.86	0.54	13.66	12.17	-0.58	0.09	29.94	12.633
36	1750	-0.67	57.20	-21.35	-0.03	-1.80	0.56	12.69	11.30	-0.61	0.12	27.87	11.759
37	1800	-0.69	53.83	-21.92	-0.10	-1.73	0.57	11.74	10.45	-0.63	0.14	25.76	10.868
38	1850	-0.70	50.47	-22.49	-0.16	-1.61	0.57	10.93	9.73	-0.61	0.16	23.45	9.895
39	1900	-0.72	47.10	-23.05	-0.23	-1.48	0.57	10.17	9.06	-0.60	0.18	21.39	9.025
40	1950	-0.77	44.03	-24.67	-0.43	-1.38	0.57	9.49	8.45	-0.61	0.21	19.64	8.287
41	2000	-0.86	42.88	-27.56	-0.35	-1.36	0.58	9.13	8.13	-0.67	0.26	18.86	7.957
42	2050	-0.92	43.25	-29.26	-0.39	-1.40	0.60	9.07	8.08	-0.72	0.29	18.73	7.905
43	2100	-0.97	43.62	-30.96	-0.42	-1.44	0.61	9.01	8.02	-0.77	0.32	18.61	7.855
44	2150	-1.02	43.98	-32.66	-0.45	-1.48	0.63	8.94	7.97	-0.82	0.35	18.49	7.804
45	2200	-1.10	44.34	-35.18	-0.49	-1.53	0.65	8.84	7.87	-0.90	0.40	18.30	7.723

46	2250	-1.43	45.52	-45.52	-1.43	-1.68	0.72	8.34	7.43	-1.18	0.55	17.79	7.506
47	2300	-1.75	55.85	-55.85	-1.60	-1.82	0.77	7.78	6.93	-1.47	0.66	17.67	7.456
48	2350	-1.88	59.88	-59.88	-1.54	-1.87	0.80	7.46	6.65	-1.58	0.69	17.50	7.383
49	2400	-1.77	56.62	-56.62	-1.61	-1.83	0.80	7.22	6.43	-1.51	0.70	16.46	6.945
50	2450	-1.67	53.36	-53.36	-1.66	-1.80	0.79	7.27	6.47	-1.43	0.69	16.03	6.766
51	2500	-1.57	50.09	-50.09	-1.55	-1.80	0.77	7.82	6.96	-1.33	0.64	16.71	7.052
52	2550	-1.47	46.83	-46.83	-1.48	-1.81	0.74	8.37	7.45	-1.25	0.59	17.49	7.38
53	2600	-1.40	48.70	-44.71	-0.78	-1.84	0.73	8.87	7.90	-1.20	0.54	18.35	7.744
54	2650	-1.33	50.61	-42.60	-0.84	-1.87	0.71	9.40	8.37	-1.15	0.49	19.41	8.19
55	2700	-1.31	52.51	-41.87	-0.90	-1.91	0.70	9.87	8.79	-1.13	0.46	20.39	8.606
56	2750	-1.35	54.42	-43.06	-0.97	-1.99	0.70	10.22	9.10	-1.17	0.46	21.12	8.914
57	2800	-1.39	56.33	-44.25	-1.00	-2.06	0.70	10.56	9.41	-1.21	0.46	21.86	9.224
58	2850	-1.42	58.23	-45.44	-1.00	-2.11	0.69	11.04	9.83	-1.23	0.44	22.82	9.628
59	2900	-1.46	60.13	-46.62	-0.93	-2.14	0.68	11.57	10.30	-1.24	0.43	23.88	10.078
60	2950	-1.48	62.03	-47.15	-0.90	-2.18	0.67	12.11	10.78	-1.24	0.41	24.99	10.546
61	3000	-1.50	63.62	-47.77	-0.87	-2.21	0.66	12.55	11.18	-1.25	0.39	25.90	10.931
62	3050	-1.54	63.23	-49.28	-0.84	-2.22	0.67	12.36	11.01	-1.29	0.41	25.51	10.766
63	3100	-1.59	62.84	-50.79	-0.84	-2.23	0.68	12.17	10.84	-1.33	0.44	25.14	10.61
64	3150	-1.64	62.44	-52.30	-0.84	-2.24	0.68	11.98	10.67	-1.37	0.46	24.79	10.461
65	3200	-1.69	62.06	-53.82	-0.84	-2.25	0.69	11.80	10.51	-1.41	0.48	24.47	10.325
66	3250	-1.71	62.10	-54.68	-0.84	-2.27	0.70	11.74	10.46	-1.43	0.49	24.36	10.279
67	3300	-1.77	62.89	-56.55	-0.94	-2.33	0.71	11.67	10.40	-1.50	0.51	24.19	10.21
68	3350	-1.92	63.67	-61.25	-1.89	-2.44	0.74	11.45	10.20	-1.64	0.57	23.79	10.039

69	3400	-2.07	65.95	-65.95	-2.06	-2.54	0.76	11.23	10.00	-1.78	0.62	23.42	9.884
70	3450	-2.21	70.64	-70.64	-2.23	-2.65	0.78	11.02	9.81	-1.92	0.66	23.08	9.741
71	3500	-2.36	75.33	-75.33	-2.36	-2.75	0.80	10.81	9.63	-2.06	0.69	22.78	9.613
72	3550	-2.51	80.03	-80.03	-2.49	-2.88	0.83	10.35	9.22	-2.22	0.74	21.80	9.201
73	3600	-2.67	85.34	-85.34	-2.62	-3.02	0.85	9.82	8.74	-2.40	0.79	20.72	8.742
74	3650	-2.71	86.47	-86.47	-2.73	-3.11	0.87	9.48	8.44	-2.47	0.81	19.79	8.35
75	3700	-2.64	84.29	-84.29	-2.13	-3.15	0.88	9.37	8.34	-2.44	0.82	19.35	8.164
76	3750	-2.57	82.11	-82.11	-2.13	-3.19	0.88	9.35	8.33	-2.42	0.81	19.39	8.184
77	3800	-2.50	79.93	-79.93	-2.04	-3.23	0.88	9.43	8.40	-2.40	0.80	19.93	8.41
78	3850	-2.41	76.94	-76.94	-1.95	-3.26	0.88	9.68	8.62	-2.36	0.77	21.14	8.92
79	3900	-2.31	74.41	-73.61	-1.95	-3.27	0.87	9.89	8.81	-2.31	0.74	22.59	9.533
80	3950	-2.20	78.37	-70.28	-1.95	-3.29	0.87	10.20	9.08	-2.26	0.70	24.44	10.314
81	4000	-2.10	77.08	-66.95	-1.87	-3.22	0.85	10.53	9.38	-2.16	0.67	25.27	10.664
82	4050	-1.99	75.50	-63.62	-1.72	-3.15	0.84	10.86	9.67	-2.05	0.63	26.03	10.985
83	4100	-1.89	73.91	-60.29	-1.60	-3.08	0.82	11.19	9.97	-1.95	0.59	26.79	11.306
84	4150	-1.78	72.33	-56.96	-1.48	-3.01	0.81	11.53	10.27	-1.85	0.55	27.56	11.631
85	4200	-1.68	70.75	-53.63	-1.38	-2.93	0.79	11.76	10.47	-1.75	0.52	28.15	11.877
86	4250	-1.58	69.16	-50.30	-1.29	-2.84	0.78	11.76	10.47	-1.65	0.48	28.33	11.953
87	4300	-1.47	67.57	-46.97	-1.20	-2.75	0.77	11.77	10.48	-1.55	0.45	28.52	12.034
88	4350	-1.37	66.00	-43.64	-1.80	-2.65	0.76	11.78	10.49	-1.46	0.42	28.72	12.121
89	4400	-1.26	64.41	-40.31	-1.67	-2.56	0.75	11.79	10.50	-1.36	0.38	28.93	12.206
90	4450	-1.16	62.82	-36.98	-1.53	-2.47	0.73	11.80	10.51	-1.26	0.34	29.13	12.292
91	4500	-1.04	60.69	-33.10	-1.37	-2.35	0.71	11.74	10.46	-1.15	0.30	29.17	12.31

92	4550	-0.93	58.75	-29.83	-1.23	-2.25	0.70	11.65	10.38	-1.05	0.27	29.11	12.285
93	4600	-0.85	57.20	-27.17	-1.11	-2.17	0.68	11.59	10.32	-0.97	0.24	29.09	12.274
94	4650	-0.78	54.77	-24.93	-1.03	-2.06	0.68	11.25	10.02	-0.90	0.22	28.30	11.944
95	4700	-0.98	52.34	-31.42	-1.32	-2.07	0.73	9.86	8.78	-1.07	0.35	24.20	10.214
96	4750	-1.19	49.91	-37.90	-0.96	-2.08	0.79	8.52	7.59	-1.23	0.50	20.26	8.548
97	4800	-1.39	47.49	-44.39	-1.11	-2.10	0.84	7.28	6.48	-1.39	0.66	16.56	6.986
98	4850	-1.59	50.87	-50.87	-1.28	-2.11	0.88	6.12	5.45	-1.55	0.79	13.22	5.579
99	4900	-1.80	57.35	-57.35	-1.55	-2.13	0.92	5.08	4.53	-1.72	0.88	10.54	4.448
100	4950	-2.00	63.84	-63.84	-1.97	-2.16	0.94	4.25	3.79	-1.88	0.92	8.95	3.779
101	5000	-2.10	67.00	-67.00	-2.04	-2.13	0.95	3.81	3.40	-1.96	0.93	8.65	3.649
102	5050	-2.09	66.56	-66.56	-1.96	-2.07	0.95	3.55	3.16	-1.94	0.94	8.48	3.578
103	5100	-2.07	66.12	-66.12	-2.06	-2.00	0.96	3.34	2.97	-1.92	0.93	8.48	3.578
104	5150	-2.06	65.68	-65.68	-2.06	-1.93	0.96	3.23	2.88	-1.90	0.93	8.73	3.682
105	5200	-2.04	65.24	-65.24	-1.95	-1.99	0.91	4.88	4.35	-1.84	0.87	11.90	5.02
106	5250	-2.03	64.81	-64.81	-1.81	-2.04	0.86	6.53	5.82	-1.78	0.79	15.20	6.412
107	5300	-2.02	64.37	-64.37	-1.74	-2.00	0.85	6.62	5.90	-1.75	0.78	15.67	6.614
108	5350	-2.00	63.94	-63.94	-1.81	-1.95	0.84	6.71	5.98	-1.73	0.76	16.19	6.832
109	5400	-1.99	63.50	-63.50	-1.87	-1.90	0.83	6.82	6.07	-1.70	0.74	16.73	7.059
110	5450	-1.98	63.06	-63.06	-1.89	-1.85	0.82	6.93	6.17	-1.68	0.72	17.30	7.3
111	5500	-1.96	62.62	-62.62	-1.95	-1.81	0.80	7.05	6.28	-1.65	0.70	17.90	7.552
112	5550	-1.95	62.18	-62.18	-1.89	-1.76	0.79	7.18	6.39	-1.62	0.68	18.51	7.811
113	5600	-1.93	61.74	-61.74	-1.89	-1.71	0.77	7.33	6.53	-1.60	0.66	19.17	8.09
114	5650	-1.92	61.31	-61.31	-1.89	-1.67	0.75	7.50	6.68	-1.57	0.63	19.87	8.385

115	5700	-1.91	60.87	-60.87	-1.89	-1.62	0.74	7.67	6.83	-1.54	0.61	20.57	8.681
116	5750	-1.89	60.43	-60.43	-1.89	-1.58	0.71	7.85	6.99	-1.52	0.58	21.30	8.987
117	5800	-1.88	59.99	-59.99	-1.88	-1.53	0.69	8.03	7.15	-1.49	0.56	22.03	9.297
118	5850	-1.87	59.55	-59.55	-0.81	-1.48	0.67	8.22	7.32	-1.46	0.53	22.77	9.608
119	5900	-1.93	61.62	-61.62	-0.81	-1.55	0.67	8.56	7.63	-1.51	0.53	23.55	9.936
120	5950	-2.01	64.30	-64.30	-1.97	-1.65	0.68	8.95	7.97	-1.58	0.54	24.34	10.272
121	6000	-2.10	66.99	-66.99	-2.06	-1.75	0.68	9.37	8.35	-1.65	0.54	25.19	10.63
122	6050	-2.18	69.67	-69.67	-2.16	-1.84	0.69	9.82	8.75	-1.72	0.55	26.09	11.011
123	6100	-2.27	72.35	-72.35	-2.24	-2.10	0.79	8.48	7.55	-1.90	0.69	21.31	8.992
124	6150	-2.35	75.04	-75.04	-2.26	-2.19	0.78	9.07	8.08	-1.96	0.67	22.66	9.564
125	6200	-2.44	77.72	-77.72	-2.34	-2.28	0.78	9.67	8.62	-2.02	0.66	24.03	10.139
126	6250	-2.52	80.40	-80.40	-2.35	-2.37	0.77	10.27	9.15	-2.08	0.65	25.39	10.713
127	6300	-2.60	83.08	-83.08	-2.37	-2.46	0.76	10.88	9.69	-2.14	0.64	26.76	11.29
128	6350	-2.63	83.85	-83.85	-2.37	-2.49	0.76	11.08	9.87	-2.16	0.64	27.11	11.441
129	6400	-2.63	84.01	-84.01	-2.37	-2.49	0.77	10.86	9.67	-2.17	0.65	26.64	11.24
130	6450	-2.64	84.17	-84.17	-2.46	-2.50	0.77	10.64	9.48	-2.19	0.66	26.15	11.037
131	6500	-2.64	84.33	-84.33	-2.46	-2.50	0.78	10.42	9.29	-2.20	0.67	25.68	10.836
132	6550	-2.65	84.50	-84.50	-2.48	-2.50	0.79	10.21	9.09	-2.21	0.68	25.20	10.636
133	6600	-2.65	84.66	-84.66	-2.47	-2.51	0.79	10.19	9.08	-2.22	0.68	25.07	10.58
134	6650	-2.66	84.82	-84.82	-2.37	-2.55	0.79	10.48	9.33	-2.22	0.68	25.48	10.753
135	6700	-2.66	84.98	-84.98	-2.34	-2.58	0.78	10.80	9.62	-2.22	0.67	26.03	10.982
136	6750	-2.67	85.14	-85.14	-2.26	-2.61	0.77	11.14	9.92	-2.22	0.66	26.59	11.22
137	6800	-2.67	85.31	-85.31	-2.24	-2.64	0.77	11.47	10.22	-2.22	0.65	27.15	11.459

138	6850	-2.68	85.47	-85.47	-2.15	-2.67	0.76	11.82	10.52	-2.22	0.64	27.74	11.705
139	6900	-2.68	85.63	-85.63	-2.26	-2.70	0.75	12.16	10.83	-2.21	0.63	28.33	11.955
140	6950	-2.69	85.79	-85.79	-2.34	-2.73	0.75	12.50	11.14	-2.21	0.62	28.94	12.211
141	7000	-2.69	85.96	-85.96	-2.35	-2.76	0.74	12.86	11.45	-2.21	0.61	29.55	12.471
142	7050	-2.72	86.91	-86.91	-2.37	-2.81	0.74	13.15	11.71	-2.23	0.60	30.11	12.705
143	7100	-2.76	87.93	-87.93	-2.46	-2.86	0.74	13.43	11.96	-2.26	0.60	30.65	12.933
144	7150	-2.76	87.92	-87.92	-2.46	-2.85	0.73	13.52	12.04	-2.25	0.60	30.89	13.034
145	7200	-2.75	87.61	-87.61	-2.37	-2.79	0.74	12.87	11.47	-2.26	0.61	29.78	12.565
146	7250	-2.74	87.29	-87.29	-2.24	-2.73	0.76	12.24	10.90	-2.26	0.63	28.71	12.115
147	7300	-2.73	86.99	-86.99	-2.34	-2.67	0.77	11.62	10.35	-2.26	0.65	27.69	11.683
148	7350	-2.72	86.67	-86.67	-2.46	-2.61	0.78	11.01	9.81	-2.26	0.66	26.72	11.273
149	7400	-2.71	86.36	-86.36	-2.49	-2.55	0.79	10.48	9.34	-2.26	0.68	25.91	10.932
150	7450	-2.70	86.05	-86.05	-2.59	-2.53	0.78	10.43	9.29	-2.25	0.68	25.93	10.94
151	7500	-2.69	85.73	-85.73	-2.59	-2.50	0.78	10.37	9.24	-2.24	0.67	25.94	10.946
152	7550	-2.68	85.43	-85.43	-2.61	-2.47	0.78	10.32	9.19	-2.22	0.67	25.97	10.959
153	7600	-2.67	85.11	-85.11	-2.62	-2.45	0.78	10.23	9.11	-2.22	0.67	25.87	10.918
154	7650	-2.66	84.80	-84.80	-2.62	-2.43	0.78	10.11	9.01	-2.21	0.67	25.70	10.843
155	7700	-2.65	84.49	-84.49	-2.62	-2.41	0.78	10.00	8.90	-2.20	0.67	25.52	10.768
156	7750	-2.64	84.17	-84.17	-2.62	-2.39	0.78	9.88	8.80	-2.19	0.67	25.34	10.694
157	7800	-2.63	83.87	-83.87	-2.62	-2.37	0.79	9.77	8.70	-2.19	0.68	25.17	10.621
158	7850	-2.62	83.55	-83.55	-2.62	-2.35	0.79	9.65	8.59	-2.18	0.68	24.98	10.542
159	7900	-2.61	83.20	-83.20	-2.61	-2.34	0.79	9.63	8.58	-2.17	0.68	24.94	10.523
160	7950	-2.58	82.32	-82.32	-2.49	-2.34	0.78	9.82	8.75	-2.14	0.67	25.14	10.609

161	8000	-2.55	81.45	-81.45	-2.49	-2.34	0.77	10.02	8.92	-2.11	0.66	25.36	10.702
162	8050	-2.52	80.57	-80.57	-2.46	-2.34	0.76	10.22	9.10	-2.08	0.65	25.60	10.802
163	8100	-2.50	79.68	-79.68	-2.35	-2.33	0.76	10.43	9.29	-2.05	0.63	25.85	10.907
164	8150	-2.47	78.80	-78.80	-2.26	-2.33	0.75	10.64	9.48	-2.02	0.62	26.11	11.019
165	8200	-2.44	77.92	-77.92	-2.15	-2.33	0.74	10.85	9.67	-1.99	0.61	26.39	11.136
166	8250	-2.41	77.05	-77.05	-2.06	-2.33	0.73	11.08	9.87	-1.96	0.60	26.71	11.27
167	8300	-2.39	76.17	-76.17	-2.05	-2.30	0.73	11.06	9.85	-1.93	0.59	26.63	11.237
168	8350	-2.36	75.28	-75.28	-2.06	-2.26	0.73	10.77	9.60	-1.91	0.60	26.07	11
169	8400	-2.33	74.40	-74.40	-2.06	-2.22	0.74	10.49	9.34	-1.89	0.60	25.52	10.769
170	8450	-2.31	73.74	-73.74	-2.06	-2.19	0.74	10.22	9.10	-1.88	0.61	24.99	10.544
171	8500	-2.32	74.05	-74.05	-2.13	-2.20	0.75	10.05	8.95	-1.90	0.62	24.56	10.362
172	8550	-2.33	74.37	-74.37	-2.14	-2.20	0.75	10.05	8.95	-1.90	0.62	24.69	10.419
173	8600	-2.34	74.67	-74.67	-2.15	-2.19	0.74	10.11	9.00	-1.91	0.62	24.99	10.547
174	8650	-2.35	74.99	-74.99	-2.24	-2.18	0.74	10.17	9.06	-1.91	0.61	25.30	10.678
175	8700	-2.36	75.31	-75.31	-2.26	-2.17	0.74	10.23	9.11	-1.91	0.61	25.62	10.812
176	8750	-2.37	75.62	-75.62	-2.34	-2.16	0.73	10.30	9.17	-1.92	0.60	25.95	10.949
177	8800	-2.35	74.95	-74.95	-2.26	-2.14	0.73	10.35	9.22	-1.89	0.59	26.07	11.001
178	8850	-2.33	74.22	-74.22	-2.26	-2.12	0.72	10.40	9.26	-1.87	0.59	26.18	11.049
179	8900	-2.30	73.48	-73.48	-2.24	-2.10	0.71	10.45	9.30	-1.84	0.58	26.29	11.095
180	8950	-2.28	72.75	-72.75	-2.24	-2.07	0.71	10.50	9.35	-1.82	0.57	26.41	11.143
181	9000	-2.26	72.02	-72.02	-2.15	-2.05	0.70	10.55	9.39	-1.79	0.56	26.52	11.19
182	9050	-2.23	71.28	-71.28	-2.15	-2.03	0.70	10.56	9.40	-1.77	0.55	26.57	11.211
183	9100	-2.21	70.56	-70.56	-2.15	-2.00	0.69	10.55	9.40	-1.75	0.54	26.59	11.22

184	9150	-2.19	69.83	-69.83	-2.13	-1.97	0.68	10.55	9.39	-1.72	0.54	26.61	11.229
185	9200	-2.16	69.09	-69.09	-2.13	-1.95	0.68	10.54	9.39	-1.70	0.53	26.63	11.236
186	9250	-2.14	68.36	-68.36	-2.04	-1.96	0.70	10.07	8.97	-1.70	0.56	25.17	10.622
187	9300	-2.12	67.63	-67.63	-1.95	-2.00	0.74	9.40	8.37	-1.72	0.61	23.07	9.737
188	9350	-2.10	66.89	-66.89	-1.81	-2.03	0.77	8.80	7.84	-1.73	0.65	21.20	8.944
189	9400	-2.07	66.16	-66.16	-1.81	-2.00	0.76	8.76	7.81	-1.71	0.65	21.11	8.91
190	9450	-2.05	65.44	-65.44	-1.80	-1.98	0.76	8.72	7.77	-1.69	0.64	21.03	8.874
191	9500	-2.03	64.70	-64.70	-1.80	-1.96	0.76	8.68	7.74	-1.67	0.64	20.94	8.838
192	9550	-2.00	63.97	-63.97	-1.74	-1.93	0.76	8.65	7.70	-1.65	0.63	20.87	8.805
193	9600	-1.98	63.24	-63.24	-1.73	-1.91	0.75	8.61	7.67	-1.63	0.63	20.78	8.769
194	9650	-1.97	62.72	-62.72	-1.73	-1.90	0.75	8.59	7.65	-1.61	0.63	20.72	8.742
195	9700	-1.95	62.22	-62.22	-1.66	-1.90	0.74	8.76	7.80	-1.59	0.61	20.98	8.855
196	9750	-1.93	61.73	-61.73	-1.60	-1.90	0.74	8.89	7.92	-1.58	0.61	21.10	8.905
197	9800	-1.92	61.24	-61.24	-1.54	-1.91	0.74	9.00	8.02	-1.56	0.60	21.20	8.945
198	9850	-1.91	60.81	-60.81	-1.55	-1.91	0.73	9.11	8.11	-1.55	0.59	21.29	8.985
199	9900	-1.89	60.42	-60.42	-1.60	-1.92	0.73	9.21	8.21	-1.54	0.59	21.39	9.027
200	9950	-1.88	59.93	-59.93	-1.61	-1.92	0.72	9.34	8.32	-1.53	0.58	21.52	9.083
201	10000	-1.86	59.43	-59.43	-1.66	-1.93	0.72	9.47	8.43	-1.51	0.57	21.65	9.138
202	10050	-1.85	58.93	-58.93	-1.66	-1.93	0.72	9.60	8.55	-1.50	0.57	21.80	9.199
203	10100	-1.83	58.44	-58.44	-1.67	-1.94	0.71	9.73	8.67	-1.48	0.56	21.96	9.265
204	10150	-1.82	57.94	-57.94	-1.67	-1.94	0.71	9.87	8.79	-1.47	0.55	22.12	9.334
205	10200	-1.80	57.45	-57.45	-1.73	-1.95	0.70	10.01	8.91	-1.45	0.54	22.29	9.408
206	10250	-1.78	56.95	-56.95	-1.73	-1.95	0.70	10.11	9.01	-1.44	0.53	22.41	9.455

207	10300	-1.77	56.45	-56.45	-1.73	-1.95	0.70	10.11	9.00	-1.43	0.53	22.32	9.417
208	10350	-1.75	55.96	-55.96	-1.73	-1.95	0.70	10.11	9.00	-1.42	0.53	22.24	9.383
209	10400	-1.74	55.46	-55.46	-1.74	-1.94	0.70	10.11	9.00	-1.40	0.53	22.15	9.348
210	10450	-1.72	54.97	-54.97	-1.67	-1.94	0.70	10.11	9.01	-1.39	0.52	22.08	9.318
211	10500	-1.71	54.47	-54.47	-1.67	-1.94	0.70	10.11	9.01	-1.38	0.52	22.00	9.284
212	10550	-1.69	53.97	-53.97	-1.67	-1.93	0.69	10.11	9.01	-1.37	0.52	21.94	9.257
213	10600	-1.68	53.48	-53.48	-1.67	-1.93	0.69	10.12	9.01	-1.36	0.52	21.87	9.23
214	10650	-1.66	52.98	-52.98	-1.66	-1.93	0.69	10.12	9.02	-1.35	0.51	21.81	9.205
215	10700	-1.64	52.49	-52.49	-1.61	-1.93	0.69	10.12	9.01	-1.33	0.51	21.73	9.17
216	10750	-1.67	53.33	-53.33	-1.67	-1.94	0.70	10.06	8.96	-1.36	0.52	21.65	9.135
217	10800	-1.71	54.55	-54.55	-1.67	-1.97	0.70	10.14	9.03	-1.39	0.53	21.86	9.225
218	10850	-1.75	55.95	-55.77	-1.74	-2.05	0.69	10.90	9.71	-1.41	0.50	23.44	9.893
219	10900	-1.79	58.93	-57.00	-1.74	-2.12	0.67	11.67	10.39	-1.43	0.47	25.02	10.56
220	10950	-1.82	61.92	-58.22	-1.81	-2.19	0.66	12.43	11.07	-1.45	0.45	26.61	11.23
221	11000	-1.86	64.89	-59.44	-1.87	-2.26	0.65	13.20	11.75	-1.47	0.43	28.20	11.898
222	11050	-1.90	67.87	-60.66	-1.89	-2.33	0.63	13.96	12.44	-1.49	0.41	29.78	12.569
223	11100	-1.94	70.85	-61.88	-1.89	-2.40	0.62	14.73	13.12	-1.50	0.39	31.38	13.24
224	11150	-1.98	70.99	-63.11	-1.97	-2.42	0.63	14.68	13.08	-1.54	0.40	31.34	13.225
225	11200	-2.02	69.88	-64.33	-1.97	-2.43	0.64	14.28	12.72	-1.58	0.43	30.60	12.912
226	11250	-2.05	68.76	-65.55	-2.05	-2.43	0.66	13.88	12.36	-1.62	0.45	29.86	12.601
227	11300	-2.09	67.65	-66.77	-2.06	-2.43	0.67	13.48	12.00	-1.67	0.48	29.14	12.298
228	11350	-2.13	68.00	-68.00	-2.06	-2.43	0.68	13.08	11.65	-1.71	0.50	28.44	12.001
229	11400	-2.17	69.22	-69.22	-2.16	-2.44	0.70	12.69	11.30	-1.75	0.52	27.74	11.707

230	11450	-2.21	70.44	-70.44	-2.15	-2.44	0.71	12.30	10.95	-1.79	0.55	27.07	11.422
231	11500	-2.25	71.67	-71.67	-2.15	-2.44	0.72	11.91	10.61	-1.84	0.57	26.41	11.145
232	11550	-2.28	72.88	-72.88	-2.15	-2.44	0.74	11.53	10.27	-1.88	0.60	25.76	10.869
233	11600	-2.32	74.11	-74.11	-2.14	-2.45	0.75	11.15	9.93	-1.92	0.62	25.14	10.608
234	11650	-2.36	75.33	-75.33	-2.13	-2.45	0.76	10.78	9.60	-1.96	0.64	24.54	10.354
235	11700	-2.40	76.55	-76.55	-2.13	-2.45	0.77	10.53	9.38	-2.00	0.65	24.21	10.214
236	11750	-2.44	77.78	-77.78	-2.13	-2.46	0.77	10.48	9.34	-2.04	0.66	24.34	10.27
237	11800	-2.48	78.99	-78.99	-2.04	-2.47	0.78	10.44	9.30	-2.07	0.66	24.48	10.33
238	11850	-2.51	80.22	-80.22	-2.13	-2.48	0.78	10.41	9.27	-2.10	0.67	24.64	10.399
239	11900	-2.55	81.45	-81.45	-2.24	-2.49	0.78	10.38	9.24	-2.13	0.67	24.82	10.474
240	11950	-2.59	82.66	-82.66	-2.26	-2.50	0.78	10.36	9.23	-2.16	0.67	25.04	10.567
241	12000	-2.63	83.89	-83.89	-2.49	-2.46	0.78	10.40	9.26	-2.18	0.66	25.86	10.914
242	12050	-2.67	85.10	-85.10	-2.62	-2.41	0.77	10.41	9.27	-2.20	0.65	26.71	11.27
243	12100	-2.71	86.33	-86.33	-2.62	-2.36	0.76	10.47	9.32	-2.22	0.64	27.66	11.672
244	12150	-2.74	87.56	-87.56	-2.74	-2.31	0.75	10.57	9.41	-2.24	0.63	28.72	12.12
245	12200	-2.78	88.77	-88.77	-1.38	-2.26	0.74	10.71	9.54	-2.25	0.61	29.87	12.604
246	12250	-2.82	90.00	-90.00	-1.37	-2.18	0.70	11.31	10.08	-2.25	0.57	32.43	13.685
247	12300	-2.81	89.71	-89.71	-1.19	-2.06	0.63	12.42	11.06	-2.18	0.50	36.09	15.23
248	12350	-2.74	87.88	-87.50	-1.00	-1.94	0.56	13.41	11.94	-2.06	0.44	38.87	16.405
249	12400	-2.67	91.59	-85.29	-0.78	-1.82	0.50	14.40	12.83	-1.94	0.38	41.67	17.582
250	12450	-2.60	94.58	-83.08	-0.62	-1.71	0.44	15.21	13.55	-1.83	0.32	43.97	18.554
251	12500	-2.53	93.32	-80.87	-0.55	-1.65	0.42	15.16	13.50	-1.77	0.31	43.70	18.443
252	12550	-2.46	92.06	-78.66	-0.49	-1.60	0.41	15.11	13.46	-1.70	0.30	43.44	18.331

253	12600	-2.40	83.55	-76.45	-0.60	-1.66	0.48	13.70	12.21	-1.71	0.35	38.97	16.444
254	12650	-2.33	74.42	-74.23	-0.73	-1.72	0.55	12.20	10.86	-1.72	0.41	34.17	14.417
255	12700	-2.26	72.02	-72.02	-2.26	-1.79	0.63	10.74	9.56	-1.74	0.49	29.45	12.429
256	12750	-2.19	69.81	-69.81	-2.16	-1.88	0.71	9.57	8.53	-1.74	0.57	25.23	10.648
257	12800	-2.12	67.60	-67.60	-2.04	-1.97	0.77	8.50	7.57	-1.75	0.65	21.25	8.966
258	12850	-2.07	66.04	-66.04	-1.80	-2.03	0.79	8.20	7.30	-1.74	0.69	19.56	8.256
259	12900	-2.03	64.79	-64.79	-1.74	-2.05	0.79	8.40	7.48	-1.71	0.68	19.53	8.242
260	12950	-1.99	63.44	-63.44	-1.81	-2.07	0.78	8.65	7.71	-1.67	0.67	19.60	8.269
261	13000	-1.95	62.07	-62.07	-1.89	-2.10	0.77	8.95	7.97	-1.64	0.65	19.81	8.361
262	13050	-1.90	60.69	-60.69	-1.89	-2.12	0.76	9.30	8.29	-1.60	0.63	20.23	8.538
263	13100	-1.86	59.32	-59.32	-1.81	-2.14	0.75	9.68	8.62	-1.56	0.61	20.74	8.752
264	13150	-1.82	57.94	-57.94	-1.81	-2.16	0.74	10.07	8.97	-1.53	0.59	21.33	8.999
265	13200	-1.77	56.58	-56.58	-1.74	-2.16	0.73	10.24	9.12	-1.50	0.57	21.50	9.073
266	13250	-1.79	57.10	-57.10	-1.80	-2.19	0.74	10.24	9.12	-1.52	0.58	21.47	9.062
267	13300	-1.81	57.80	-57.80	-1.81	-2.22	0.74	10.24	9.12	-1.54	0.59	21.45	9.049
268	13350	-1.83	58.49	-58.49	-1.81	-2.25	0.75	10.23	9.11	-1.56	0.60	21.41	9.034
269	13400	-1.85	59.19	-59.19	-1.87	-2.28	0.75	10.23	9.11	-1.59	0.60	21.38	9.024
270	13450	-1.88	59.88	-59.88	-1.88	-2.29	0.75	10.32	9.19	-1.60	0.60	21.59	9.113
271	13500	-1.90	60.57	-60.57	-1.89	-2.31	0.75	10.41	9.27	-1.62	0.60	21.81	9.205
272	13550	-1.92	61.26	-61.26	-1.89	-2.32	0.75	10.46	9.32	-1.64	0.61	21.95	9.264
273	13600	-1.94	61.96	-61.96	-1.95	-2.32	0.76	10.15	9.04	-1.66	0.63	21.35	9.011
274	13650	-1.96	62.66	-62.66	-1.96	-2.31	0.77	9.84	8.76	-1.69	0.65	20.77	8.765
275	13700	-1.99	63.35	-63.35	-1.97	-2.30	0.78	9.52	8.48	-1.71	0.67	20.19	8.519

276	13750	-2.01	64.05	-64.05	-1.97	-2.30	0.79	9.22	8.21	-1.74	0.68	19.62	8.28
277	13800	-2.03	64.74	-64.74	-2.04	-2.29	0.80	8.91	7.94	-1.76	0.70	19.07	8.045
278	13850	-2.05	65.44	-65.44	-2.05	-2.28	0.81	8.61	7.67	-1.78	0.72	18.52	7.816
279	13900	-2.07	66.13	-66.13	-2.06	-2.28	0.82	8.31	7.40	-1.81	0.74	17.99	7.592
280	13950	-2.09	66.83	-66.83	-2.06	-2.27	0.83	8.01	7.13	-1.83	0.75	17.47	7.373
281	14000	-2.09	66.76	-66.76	-2.06	-2.23	0.84	7.63	6.79	-1.83	0.77	16.84	7.105
282	14050	-2.09	66.62	-66.62	-1.97	-2.18	0.85	7.24	6.45	-1.83	0.78	16.21	6.842
283	14100	-2.08	66.48	-66.48	-1.95	-2.14	0.86	6.87	6.12	-1.83	0.79	15.64	6.598
284	14150	-2.08	66.34	-66.34	-1.87	-2.09	0.87	6.51	5.79	-1.83	0.80	15.11	6.374
285	14200	-2.07	66.18	-66.18	-1.80	-2.08	0.86	6.56	5.84	-1.82	0.80	15.35	6.476
286	14250	-2.07	66.04	-66.04	-1.80	-2.06	0.85	6.72	5.99	-1.81	0.78	15.79	6.664
287	14300	-2.07	65.90	-65.90	-1.80	-2.05	0.85	6.88	6.13	-1.79	0.77	16.23	6.849
288	14350	-2.03	64.73	-64.73	-1.73	-2.02	0.84	7.04	6.27	-1.75	0.76	16.53	6.975
289	14400	-1.95	62.35	-62.35	-1.74	-1.98	0.82	7.22	6.43	-1.68	0.74	16.67	7.036
290	14450	-1.88	59.98	-59.98	-1.73	-1.94	0.81	7.40	6.60	-1.61	0.72	16.86	7.113
291	14500	-1.81	57.61	-57.61	-1.67	-1.90	0.79	7.60	6.77	-1.54	0.69	17.07	7.202
292	14550	-1.73	55.24	-55.24	-1.67	-1.86	0.78	7.80	6.94	-1.46	0.66	17.30	7.301
293	14600	-1.66	52.86	-52.86	-1.61	-1.81	0.76	8.00	7.13	-1.39	0.63	17.56	7.412
294	14650	-1.58	50.49	-50.49	-1.55	-1.77	0.74	8.21	7.31	-1.32	0.60	17.86	7.535
295	14700	-1.50	47.74	-47.74	-1.49	-1.71	0.72	8.38	7.47	-1.23	0.56	18.09	7.633
296	14750	-1.38	44.14	-44.14	-1.38	-1.62	0.69	8.45	7.53	-1.12	0.51	18.16	7.663
297	14800	-1.40	44.57	-44.57	-1.38	-1.57	0.69	8.39	7.47	-1.12	0.51	18.35	7.743
298	14850	-1.43	45.63	-45.63	-1.32	-1.53	0.68	8.19	7.29	-1.14	0.51	18.42	7.771

299	14900	-1.46	46.70	-46.70	-1.11	-1.46	0.67	8.04	7.16	-1.15	0.51	18.82	7.942
300	14950	-1.50	47.75	-47.75	-1.33	-1.39	0.64	8.12	7.23	-1.15	0.48	19.97	8.428
301	15000	-1.53	48.82	-48.82	-1.49	-1.31	0.61	8.28	7.38	-1.15	0.45	21.40	9.032
302	15050	-1.56	49.88	-49.88	-1.55	-1.23	0.56	8.53	7.60	-1.16	0.41	23.05	9.725
303	15100	-1.60	53.43	-50.95	-0.44	-1.15	0.51	8.85	7.89	-1.16	0.37	24.88	10.498
304	15150	-1.63	58.31	-52.01	-0.42	-1.07	0.45	9.24	8.23	-1.16	0.34	26.84	11.325
305	15200	-1.66	63.20	-53.07	-0.40	-0.99	0.39	9.69	8.63	-1.16	0.31	28.91	12.201
306	15250	-2.09	68.09	-66.61	-0.84	-1.38	0.56	9.71	8.65	-1.58	0.45	29.25	12.344
307	15300	-2.56	81.66	-81.66	-1.33	-1.84	0.69	9.76	8.69	-2.05	0.57	29.48	12.441
308	15350	-3.03	96.69	-96.69	-1.81	-2.30	0.77	9.80	8.73	-2.52	0.67	29.71	12.539
309	15400	-3.50	111.74	-111.74	-2.36	-2.74	0.83	9.74	8.67	-2.99	0.74	29.80	12.576
310	15450	-3.98	127.17	-127.17	-2.92	-3.18	0.87	9.65	8.60	-3.48	0.79	29.94	12.634
311	15500	-4.35	138.94	-138.94	-3.51	-3.43	0.89	9.67	8.62	-3.85	0.81	30.91	13.043
312	15550	-4.52	144.25	-144.25	-3.73	-3.38	0.87	10.07	8.97	-4.02	0.80	33.02	13.935
313	15600	-4.69	149.55	-149.55	-3.74	-3.35	0.85	10.92	9.72	-4.17	0.79	35.82	15.114
314	15650	-4.85	154.86	-154.86	-3.79	-3.42	0.84	11.95	10.64	-4.28	0.77	39.27	16.57
315	15700	-5.02	160.17	-160.17	-3.98	-3.50	0.82	13.01	11.59	-4.38	0.74	42.75	18.041
316	15750	-5.19	165.48	-165.48	-3.98	-3.57	0.80	14.10	12.55	-4.48	0.72	46.27	19.525
317	15800	-5.35	170.79	-170.79	-4.04	-3.64	0.78	15.20	13.53	-4.59	0.70	49.80	21.016
318	15850	-5.52	176.10	-176.10	-4.04	-3.71	0.76	16.31	14.53	-4.69	0.68	53.36	22.517
319	15900	-5.68	181.41	-181.41	-4.33	-3.79	0.75	17.44	15.53	-4.79	0.66	56.93	24.025
320	15950	-5.85	186.72	-186.72	-4.33	-3.90	0.74	18.00	16.03	-4.93	0.66	58.76	24.794
321	16000	-6.02	192.03	-192.03	-4.41	-4.00	0.74	18.48	16.46	-5.07	0.66	60.35	25.467

322	16050	-6.18	197.34	-197.34	-4.66	-4.11	0.74	18.97	16.89	-5.22	0.66	61.95	26.142
323	16100	-6.35	202.64	-202.64	-4.68	-4.22	0.75	19.45	17.33	-5.36	0.66	63.55	26.816
324	16150	-6.52	207.95	-207.95	-4.75	-4.33	0.75	19.94	17.76	-5.50	0.66	65.15	27.492
325	16200	-6.68	213.26	-213.26	-5.09	-4.44	0.75	20.42	18.19	-5.64	0.66	66.75	28.168
326	16250	-6.85	218.60	-218.60	-5.09	-4.55	0.75	20.91	18.62	-5.79	0.66	68.35	28.842
327	16300	-7.04	224.60	-224.60	-5.20	-4.69	0.75	21.37	19.03	-5.95	0.67	69.85	29.476
328	16350	-7.23	230.60	-230.60	-5.20	-4.83	0.75	21.84	19.45	-6.11	0.67	71.36	30.112
329	16400	-7.37	235.34	-235.34	-5.61	-4.96	0.76	22.16	19.74	-6.25	0.67	72.38	30.543
330	16450	-7.23	230.81	-230.81	-5.20	-4.85	0.76	21.22	18.90	-6.16	0.69	69.52	29.335
331	16500	-7.09	226.28	-226.28	-5.20	-4.67	0.76	20.85	18.57	-6.06	0.68	68.47	28.895
332	16550	-6.95	221.76	-221.76	-5.11	-4.44	0.73	21.17	18.86	-5.92	0.67	69.58	29.364
333	16600	-6.81	217.23	-217.23	-5.09	-4.20	0.70	21.54	19.19	-5.78	0.65	70.75	29.855
334	16650	-6.67	212.70	-212.70	-4.75	-3.96	0.67	21.96	19.56	-5.64	0.63	72.00	30.384
335	16700	-6.71	214.24	-214.24	-4.75	-3.99	0.67	22.11	19.69	-5.68	0.63	72.50	30.595
336	16750	-6.78	216.36	-216.36	-4.75	-4.05	0.67	22.23	19.80	-5.74	0.63	72.90	30.763
337	16800	-6.85	218.47	-218.47	-5.09	-4.10	0.68	22.35	19.90	-5.80	0.63	73.30	30.931
338	16850	-6.91	220.58	-220.58	-5.09	-4.20	0.69	22.42	19.97	-5.84	0.64	73.64	31.075
339	16900	-6.98	222.69	-222.69	-5.09	-4.31	0.69	22.52	20.06	-5.88	0.64	74.01	31.232
340	16950	-7.04	224.80	-224.80	-5.09	-4.42	0.70	22.67	20.19	-5.92	0.64	74.44	31.414
341	17000	-6.89	219.89	-219.89	-5.09	-4.40	0.72	21.72	19.35	-5.81	0.65	71.32	30.096
342	17050	-6.56	209.46	-209.46	-4.75	-4.22	0.72	20.55	18.30	-5.54	0.65	67.43	28.454
343	17100	-6.29	200.85	-200.85	-4.66	-4.09	0.73	19.60	17.46	-5.31	0.65	64.24	27.108
344	17150	-6.00	191.58	-191.58	-4.40	-3.95	0.74	18.60	16.57	-5.06	0.66	60.83	25.67

345	17200	-5.68	181.26	-181.26	-4.33	-3.80	0.74	17.51	15.59	-4.78	0.66	57.07	24.083
346	17250	-5.36	170.93	-170.93	-4.04	-3.64	0.75	16.44	14.64	-4.51	0.66	53.35	22.512
347	17300	-5.03	160.64	-160.64	-3.98	-3.49	0.76	15.40	13.72	-4.23	0.67	49.66	20.956
348	17350	-4.71	150.39	-150.39	-3.51	-3.33	0.77	14.41	12.83	-3.96	0.67	46.03	19.422
349	17400	-4.39	140.15	-140.15	-3.10	-3.18	0.78	13.41	11.94	-3.69	0.68	42.30	17.852
350	17450	-4.07	129.90	-129.90	-2.74	-3.04	0.79	12.45	11.09	-3.42	0.68	38.61	16.291
351	17500	-3.75	119.65	-119.65	-2.34	-2.89	0.80	11.56	10.29	-3.15	0.69	35.02	14.777
352	17550	-3.43	109.40	-109.40	-2.04	-2.74	0.80	10.76	9.58	-2.88	0.70	31.58	13.328
353	17600	-3.46	110.37	-110.37	-2.13	-2.74	0.80	10.71	9.54	-2.91	0.70	31.72	13.385
354	17650	-3.51	111.96	-111.96	-2.13	-2.75	0.80	10.70	9.53	-2.95	0.70	32.06	13.528
355	17700	-3.56	113.55	-113.55	-2.24	-2.76	0.81	10.71	9.53	-3.00	0.70	32.43	13.683
356	17750	-3.61	115.14	-115.14	-2.34	-2.78	0.81	10.77	9.59	-3.05	0.70	32.88	13.874
357	17800	-3.66	116.72	-116.72	-2.37	-2.80	0.80	10.90	9.71	-3.09	0.70	33.42	14.104
358	17850	-3.69	117.90	-117.90	-2.46	-2.80	0.80	11.03	9.82	-3.12	0.70	34.00	14.349
359	17900	-3.72	118.87	-118.87	-2.49	-2.80	0.80	11.16	9.94	-3.14	0.69	34.60	14.602
360	17950	-3.76	119.86	-119.86	-2.59	-2.79	0.79	11.29	10.06	-3.16	0.69	35.21	14.856
361	18000	-3.79	120.84	-120.84	-2.73	-2.84	0.81	10.81	9.63	-3.22	0.71	33.91	14.308
362	18050	-3.82	121.81	-121.81	-2.89	-2.89	0.83	10.30	9.17	-3.28	0.74	32.51	13.721
363	18100	-3.85	122.80	-122.80	-3.06	-2.93	0.85	9.80	8.72	-3.33	0.76	31.13	13.137
364	18150	-3.88	123.78	-123.78	-3.10	-2.98	0.86	9.31	8.29	-3.39	0.78	29.77	12.562
365	18200	-3.91	124.76	-124.76	-3.29	-3.03	0.88	8.83	7.86	-3.45	0.80	28.43	11.995
366	18250	-3.94	125.74	-125.74	-3.29	-3.08	0.89	8.36	7.45	-3.51	0.82	27.09	11.432
367	18300	-3.97	126.73	-126.73	-3.29	-3.13	0.91	7.93	7.07	-3.56	0.84	25.81	10.892

368	18350	-4.00	127.71	-127.71	-3.46	-3.20	0.92	7.57	6.74	-3.61	0.86	24.62	10.388
369	18400	-4.00	127.73	-127.73	-3.46	-3.23	0.93	7.23	6.44	-3.63	0.87	23.54	9.934
370	18450	-3.99	127.48	-127.48	-3.46	-3.25	0.93	6.90	6.15	-3.64	0.88	22.51	9.5
371	18500	-3.99	127.22	-127.22	-3.46	-3.26	0.94	6.57	5.85	-3.65	0.89	21.48	9.063
372	18550	-3.98	126.96	-126.96	-3.46	-3.28	0.94	6.25	5.56	-3.66	0.90	20.46	8.634
373	18600	-3.97	126.70	-126.70	-3.46	-3.30	0.95	5.93	5.28	-3.67	0.91	19.44	8.204
374	18650	-3.96	126.44	-126.44	-3.48	-3.31	0.96	5.61	5.00	-3.68	0.92	18.42	7.775
375	18700	-3.95	126.19	-126.19	-3.49	-3.33	0.96	5.30	4.72	-3.69	0.93	17.42	7.353
376	18750	-3.95	125.92	-125.92	-3.51	-3.35	0.97	5.00	4.45	-3.71	0.93	16.43	6.931
377	18800	-3.94	125.67	-125.67	-3.51	-3.36	0.97	4.71	4.19	-3.72	0.94	15.45	6.518
378	18850	-3.93	125.41	-125.41	-3.51	-3.38	0.97	4.42	3.94	-3.73	0.95	14.47	6.108
379	18900	-3.92	125.15	-125.15	-3.51	-3.40	0.98	4.15	3.70	-3.74	0.95	13.52	5.705
380	18950	-3.90	124.49	-124.49	-3.73	-3.36	0.98	4.15	3.70	-3.76	0.96	12.84	5.418
381	19000	-3.90	124.50	-124.50	-4.03	-3.37	0.97	4.27	3.80	-3.81	0.97	11.91	5.025
382	19050	-4.14	132.23	-132.23	-4.04	-3.69	0.98	3.72	3.32	-4.07	0.98	10.08	4.253
383	19100	-4.39	139.97	-139.97	-4.33	-3.97	0.99	3.35	2.98	-4.31	0.98	9.35	3.946
384	19150	-4.63	147.71	-147.71	-4.74	-4.24	0.99	2.99	2.67	-4.55	0.99	8.66	3.655
385	19200	-4.87	155.44	-155.44	-4.75	-4.52	0.99	2.67	2.38	-4.79	0.99	8.03	3.387
386	19250	-4.98	158.77	-158.77	-5.09	-4.60	0.99	2.87	2.56	-4.89	0.99	8.56	3.612
387	19300	-5.05	161.28	-161.28	-5.18	-4.64	0.99	3.18	2.83	-4.97	0.99	9.31	3.928
388	19350	-5.13	163.79	-163.79	-5.09	-4.68	0.99	3.50	3.12	-5.04	0.99	10.08	4.255
389	19400	-5.21	166.30	-166.30	-5.13	-4.72	0.99	3.84	3.42	-5.12	0.98	10.90	4.6
390	19450	-5.29	168.81	-168.81	-5.20	-4.76	0.99	4.19	3.74	-5.20	0.98	11.72	4.947

391	19500	-5.33	170.03	-170.03	-5.20	-4.78	0.99	4.38	3.90	-5.24	0.98	12.03	5.076
392	19550	-5.33	170.14	-170.14	-5.20	-4.78	0.99	4.45	3.97	-5.25	0.98	12.11	5.109
393	19600	-5.33	170.24	-170.24	-5.20	-4.78	0.99	4.54	4.04	-5.25	0.98	12.22	5.158
394	19650	-5.34	170.34	-170.34	-5.20	-4.79	0.99	4.49	4.00	-5.25	0.98	12.14	5.124
395	19700	-5.21	166.35	-166.35	-5.14	-4.65	0.99	4.47	3.98	-5.12	0.98	12.42	5.242
396	19750	-5.08	162.00	-162.00	-5.20	-4.50	0.98	4.50	4.01	-4.97	0.98	12.85	5.422
397	19800	-4.94	157.66	-157.66	-4.75	-4.35	0.98	4.56	4.06	-4.82	0.97	13.31	5.615
398	19850	-4.80	153.31	-153.31	-4.66	-4.20	0.98	4.63	4.12	-4.67	0.97	13.80	5.822
399	19900	-4.67	148.98	-148.98	-4.41	-4.05	0.98	4.72	4.20	-4.52	0.96	14.32	6.041
400	19950	-4.53	144.63	-144.63	-4.33	-3.90	0.98	4.82	4.29	-4.37	0.96	14.85	6.267
401	20000	-4.40	140.29	-140.29	-4.04	-3.75	0.97	4.93	4.39	-4.22	0.95	15.41	6.503
402	20050	-4.26	135.95	-135.95	-3.98	-3.57	0.97	5.31	4.73	-4.05	0.94	16.96	7.156
403	20100	-4.12	131.60	-131.60	-3.73	-3.35	0.95	6.16	5.49	-3.85	0.91	20.07	8.469
404	20150	-3.99	127.26	-127.26	-3.46	-3.12	0.92	7.10	6.32	-3.65	0.87	23.31	9.836
405	20200	-3.85	122.92	-122.92	-3.10	-2.90	0.89	8.10	7.22	-3.45	0.82	26.63	11.237
406	20250	-3.74	119.26	-119.26	-2.92	-2.71	0.85	9.12	8.12	-3.28	0.77	29.90	12.617
407	20300	-3.70	117.92	-117.92	-2.89	-2.63	0.81	9.94	8.85	-3.19	0.73	32.38	13.663
408	20350	-3.65	116.50	-116.50	-2.92	-2.54	0.77	10.88	9.69	-3.09	0.68	35.15	14.834
409	20400	-3.60	114.96	-114.96	-2.62	-2.45	0.72	11.98	10.67	-2.98	0.63	38.32	16.172
410	20450	-3.55	113.40	-113.40	-2.48	-2.32	0.67	12.98	11.56	-2.87	0.57	41.36	17.453
411	20500	-3.50	111.84	-111.84	-2.36	-2.19	0.61	13.90	12.38	-2.78	0.52	44.30	18.694
412	20550	-3.46	114.36	-110.28	-2.24	-2.05	0.54	14.82	13.20	-2.68	0.47	47.23	19.931
413	20600	-3.41	119.02	-108.73	-2.13	-1.92	0.48	15.75	14.02	-2.58	0.42	50.16	21.168

414	20650	-3.36	123.68	-107.17	-1.97	-1.78	0.42	16.67	14.84	-2.48	0.38	53.10	22.406
415	20700	-3.31	128.36	-105.62	-1.87	-1.65	0.35	17.59	15.67	-2.39	0.33	56.04	23.647
416	20750	-3.29	133.02	-105.09	-1.73	-1.56	0.31	18.51	16.49	-2.32	0.30	58.87	24.842
417	20800	-3.32	137.68	-106.06	-1.60	-1.54	0.28	19.43	17.31	-2.30	0.28	61.56	25.977
418	20850	-3.35	142.35	-107.04	-1.48	-1.52	0.26	20.36	18.14	-2.28	0.26	64.26	27.118
419	20900	-3.38	147.01	-108.01	-1.33	-1.50	0.23	21.30	18.97	-2.27	0.24	66.97	28.261
420	20950	-3.41	151.67	-108.97	-1.23	-1.47	0.21	22.24	19.81	-2.25	0.22	69.69	29.407
421	21000	-3.44	153.25	-109.80	-1.15	-1.49	0.21	22.59	20.12	-2.25	0.22	70.61	29.796
422	21050	-3.47	153.96	-110.64	-1.08	-1.54	0.22	22.85	20.35	-2.27	0.22	71.11	30.006
423	21100	-3.49	154.65	-111.46	-0.90	-1.60	0.23	23.27	20.73	-2.27	0.22	71.84	30.316
424	21150	-3.52	155.35	-112.29	-0.75	-1.67	0.23	23.72	21.13	-2.28	0.21	72.61	30.642
425	21200	-3.54	156.04	-113.12	-0.58	-1.73	0.24	24.19	21.55	-2.28	0.21	73.42	30.98
426	21250	-3.57	156.74	-113.95	-0.42	-1.79	0.25	24.69	21.99	-2.29	0.21	74.26	31.335
427	21300	-3.60	157.43	-114.78	-0.36	-1.83	0.25	24.94	22.21	-2.30	0.21	74.76	31.547
428	21350	-3.60	157.83	-114.96	-0.42	-1.82	0.25	24.87	22.15	-2.31	0.21	74.77	31.553
429	21400	-3.57	157.81	-113.78	-0.45	-1.76	0.24	24.75	22.04	-2.28	0.20	74.70	31.522
430	21450	-3.53	157.80	-112.60	-0.49	-1.69	0.23	24.63	21.94	-2.25	0.20	74.64	31.496
431	21500	-3.49	157.79	-111.43	-0.53	-1.63	0.22	24.51	21.83	-2.21	0.20	74.58	31.473
432	21550	-3.45	157.77	-110.25	-0.58	-1.57	0.20	24.40	21.73	-2.18	0.19	74.53	31.45
433	21600	-3.42	158.01	-109.09	-0.60	-1.50	0.19	24.34	21.68	-2.14	0.19	74.63	31.494
434	21650	-3.38	158.56	-107.91	-0.63	-1.43	0.18	24.35	21.69	-2.11	0.18	74.93	31.619
435	21700	-3.34	159.10	-106.73	-0.65	-1.36	0.16	24.36	21.69	-2.07	0.17	75.23	31.745
436	21750	-3.31	159.65	-105.56	-0.68	-1.29	0.15	24.37	21.71	-2.03	0.17	75.54	31.875

437	21800	-3.27	160.08	-104.38	-0.70	-1.22	0.13	24.37	21.70	-1.99	0.16	75.78	31.978
438	21850	-3.25	159.56	-103.59	-0.72	-1.19	0.13	24.25	21.60	-1.97	0.16	75.53	31.873
439	21900	-3.27	159.05	-104.37	-0.70	-1.24	0.14	24.20	21.56	-2.00	0.16	75.22	31.743
440	21950	-3.29	158.53	-105.15	-0.70	-1.29	0.15	24.15	21.51	-2.03	0.17	74.91	31.61
441	22000	-3.32	158.02	-105.93	-0.70	-1.34	0.16	24.11	21.47	-2.05	0.17	74.60	31.482
442	22050	-3.34	157.50	-106.71	-0.68	-1.38	0.17	24.06	21.43	-2.08	0.18	74.30	31.351
443	22100	-3.37	156.98	-107.50	-0.68	-1.43	0.18	24.01	21.39	-2.11	0.18	73.99	31.222
444	22150	-3.39	156.47	-108.28	-0.67	-1.48	0.19	23.97	21.35	-2.14	0.19	73.69	31.096
445	22200	-3.42	155.95	-109.06	-0.65	-1.53	0.20	23.93	21.31	-2.17	0.19	73.39	30.97
446	22250	-3.44	155.44	-109.84	-0.65	-1.58	0.21	23.89	21.27	-2.19	0.20	73.10	30.846
447	22300	-3.46	154.78	-110.48	-0.63	-1.62	0.22	23.84	21.23	-2.22	0.20	72.76	30.702
448	22350	-3.48	154.10	-110.98	-0.60	-1.67	0.23	23.80	21.20	-2.24	0.21	72.44	30.569
449	22400	-3.49	154.05	-111.47	-0.65	-1.68	0.24	23.70	21.11	-2.26	0.21	72.24	30.484
450	22450	-3.51	154.00	-111.96	-0.73	-1.68	0.24	23.56	20.98	-2.28	0.22	71.98	30.373
451	22500	-3.52	153.95	-112.45	-0.81	-1.69	0.24	23.41	20.85	-2.30	0.22	71.72	30.264
452	22550	-3.54	153.90	-112.94	-0.87	-1.69	0.25	23.27	20.73	-2.32	0.23	71.46	30.155
453	22600	-3.55	153.85	-113.35	-0.94	-1.70	0.25	23.13	20.60	-2.34	0.23	71.21	30.049
454	22650	-3.56	153.80	-113.48	-1.00	-1.69	0.25	22.99	20.48	-2.35	0.23	70.98	29.954
455	22700	-3.56	153.75	-113.61	-1.08	-1.67	0.25	22.85	20.35	-2.36	0.24	70.76	29.86
456	22750	-3.56	153.71	-113.74	-1.15	-1.66	0.25	22.71	20.23	-2.37	0.24	70.55	29.77
457	22800	-3.57	153.66	-113.88	-1.23	-1.65	0.25	22.58	20.11	-2.38	0.24	70.34	29.681
458	22850	-3.57	153.61	-114.01	-1.28	-1.64	0.25	22.45	19.99	-2.39	0.24	70.13	29.592
459	22900	-3.58	153.56	-114.14	-1.37	-1.63	0.25	22.32	19.88	-2.40	0.25	69.92	29.506

460	22950	-3.58	153.51	-114.27	-1.43	-1.62	0.25	22.18	19.76	-2.42	0.25	69.71	29.417
461	23000	-3.58	153.46	-114.40	-1.53	-1.61	0.25	22.05	19.64	-2.43	0.25	69.51	29.331
462	23050	-3.59	153.42	-114.54	-1.59	-1.60	0.25	21.93	19.53	-2.44	0.25	69.31	29.249
463	23100	-3.59	153.37	-114.67	-1.67	-1.58	0.25	21.81	19.42	-2.45	0.26	69.12	29.167
464	23150	-3.60	150.92	-114.80	-1.80	-1.61	0.26	21.26	18.94	-2.48	0.27	67.56	28.511
465	23200	-3.62	147.52	-115.49	-1.81	-1.70	0.30	20.63	18.37	-2.54	0.29	65.52	27.65
466	23250	-3.65	144.12	-116.55	-1.89	-1.80	0.33	20.00	17.81	-2.60	0.32	63.45	26.774
467	23300	-3.69	140.71	-117.61	-1.97	-1.90	0.38	19.37	17.25	-2.67	0.34	61.37	25.896
468	23350	-3.72	137.31	-118.68	-2.04	-2.01	0.42	18.74	16.69	-2.73	0.37	59.29	25.021
469	23400	-3.76	134.06	-119.89	-2.13	-2.11	0.46	18.13	16.14	-2.80	0.40	57.28	24.169
470	23450	-3.80	130.84	-121.13	-2.15	-2.22	0.50	17.52	15.60	-2.88	0.43	55.27	23.322
471	23500	-3.83	127.62	-122.37	-2.24	-2.32	0.54	16.91	15.06	-2.95	0.46	53.26	22.476
472	23550	-3.87	124.40	-123.61	-2.34	-2.43	0.58	16.30	14.51	-3.02	0.49	51.26	21.631
473	23600	-3.91	124.86	-124.86	-2.37	-2.53	0.62	15.69	13.97	-3.09	0.52	49.26	20.785
474	23650	-3.95	126.10	-126.10	-2.46	-2.64	0.65	15.08	13.43	-3.16	0.55	47.25	19.94
475	23700	-3.99	127.34	-127.34	-2.49	-2.75	0.69	14.50	12.92	-3.23	0.58	45.30	19.114
476	23750	-4.03	128.58	-128.58	-2.46	-2.88	0.72	14.14	12.60	-3.29	0.61	43.63	18.412
477	23800	-4.01	127.89	-127.89	-2.37	-2.93	0.74	13.77	12.26	-3.29	0.63	42.14	17.782
478	23850	-3.96	126.34	-126.34	-2.34	-2.94	0.75	13.39	11.92	-3.26	0.64	40.71	17.18
479	23900	-3.97	126.71	-126.71	-2.37	-2.98	0.76	13.15	11.71	-3.28	0.65	39.93	16.848
480	23950	-4.02	128.18	-128.18	-2.46	-3.03	0.77	12.99	11.57	-3.34	0.66	39.50	16.668
481	24000	-4.06	129.64	-129.64	-2.49	-3.09	0.78	12.84	11.44	-3.39	0.68	39.09	16.497
482	24050	-4.11	131.10	-131.10	-2.59	-3.14	0.79	12.74	11.34	-3.44	0.69	38.74	16.348

483	24100	-4.15	132.56	-132.56	-2.62	-3.20	0.80	12.63	11.25	-3.50	0.70	38.39	16.199
484	24150	-4.20	134.03	-134.03	-2.62	-3.26	0.81	12.52	11.15	-3.55	0.71	38.04	16.051
485	24200	-4.25	135.50	-135.50	-2.73	-3.31	0.82	12.42	11.06	-3.60	0.72	37.68	15.901
486	24250	-4.29	136.96	-136.96	-2.76	-3.37	0.82	12.31	10.96	-3.65	0.73	37.33	15.755
487	24300	-4.34	138.42	-138.42	-2.89	-3.43	0.83	12.20	10.87	-3.70	0.73	36.99	15.608
488	24350	-4.37	139.50	-139.50	-2.89	-3.47	0.84	12.09	10.77	-3.74	0.74	36.66	15.47
489	24400	-4.40	140.57	-140.57	-2.92	-3.51	0.84	11.97	10.66	-3.78	0.75	36.33	15.331
490	24450	-4.44	141.64	-141.64	-2.92	-3.55	0.85	11.89	10.59	-3.82	0.76	36.05	15.211
491	24500	-4.47	142.71	-142.71	-3.06	-3.60	0.85	11.84	10.55	-3.86	0.76	35.82	15.116
492	24550	-4.51	143.78	-143.78	-3.06	-3.64	0.86	11.80	10.51	-3.89	0.77	35.60	15.021
493	24600	-4.54	144.86	-144.86	-3.06	-3.69	0.86	11.75	10.47	-3.93	0.77	35.37	14.926
494	24650	-4.57	145.93	-145.93	-3.06	-3.74	0.86	11.71	10.43	-3.97	0.78	35.15	14.833
495	24700	-4.61	147.00	-147.00	-3.25	-3.79	0.87	11.67	10.39	-4.00	0.78	34.93	14.739
496	24750	-4.64	148.08	-148.08	-3.25	-3.83	0.87	11.63	10.36	-4.04	0.79	34.70	14.644
497	24800	-4.67	149.15	-149.15	-3.25	-3.88	0.87	11.59	10.32	-4.08	0.79	34.49	14.553
498	24850	-4.71	150.22	-150.22	-3.25	-3.93	0.88	11.55	10.29	-4.11	0.80	34.27	14.462
499	24900	-4.74	151.29	-151.29	-3.25	-3.98	0.88	11.51	10.25	-4.15	0.80	34.05	14.37
500	24950	-4.77	152.36	-152.36	-3.27	-4.02	0.88	11.47	10.22	-4.19	0.81	33.84	14.278
501	25000	-4.76	151.92	-151.92	-3.27	-4.01	0.88	11.40	10.15	-4.17	0.81	33.71	14.224
502	25050	-4.70	149.88	-149.88	-3.25	-3.94	0.88	11.53	10.27	-4.10	0.80	34.02	14.357
503	25100	-4.63	147.86	-147.86	-3.25	-3.88	0.87	11.66	10.39	-4.04	0.79	34.33	14.488
504	25150	-4.57	145.78	-145.78	-3.06	-3.81	0.87	11.79	10.50	-3.96	0.78	34.64	14.616
505	25200	-4.49	143.42	-143.42	-3.06	-3.75	0.86	11.91	10.61	-3.89	0.77	34.85	14.706

506	25250	-4.42	141.06	-141.06	-2.89	-3.68	0.85	12.03	10.71	-3.81	0.77	35.07	14.798
507	25300	-4.35	138.69	-138.69	-2.75	-3.61	0.85	12.14	10.81	-3.73	0.76	35.28	14.888
508	25350	-4.27	136.33	-136.33	-2.73	-3.53	0.84	12.17	10.84	-3.65	0.75	35.37	14.926
509	25400	-4.20	133.97	-133.97	-2.73	-3.44	0.83	12.07	10.75	-3.58	0.74	35.28	14.886
510	25450	-4.12	131.60	-131.60	-2.59	-3.36	0.83	11.98	10.67	-3.51	0.73	35.19	14.849
511	25500	-4.05	129.23	-129.23	-2.59	-3.27	0.82	11.89	10.59	-3.44	0.73	35.10	14.81
512	25550	-3.98	126.86	-126.86	-2.46	-3.19	0.82	11.71	10.43	-3.37	0.72	34.74	14.658
513	25600	-3.90	124.50	-124.50	-2.46	-3.11	0.82	11.52	10.26	-3.31	0.72	34.35	14.495
514	25650	-3.83	122.14	-122.14	-2.35	-3.03	0.82	11.34	10.10	-3.24	0.72	33.97	14.335
515	25700	-3.75	119.77	-119.77	-2.34	-2.95	0.81	11.15	9.93	-3.17	0.71	33.59	14.176
516	25750	-3.68	117.41	-117.41	-2.34	-2.87	0.81	10.97	9.78	-3.11	0.71	33.22	14.019
517	25800	-3.61	115.05	-115.05	-2.34	-2.79	0.81	10.80	9.62	-3.04	0.70	32.85	13.864
518	25850	-3.53	112.68	-112.68	-2.26	-2.70	0.80	10.62	9.46	-2.98	0.70	32.49	13.708
519	25900	-3.46	110.31	-110.31	-2.26	-2.62	0.80	10.45	9.31	-2.91	0.69	32.13	13.557
520	25950	-3.44	109.84	-109.84	-2.15	-2.65	0.80	10.50	9.36	-2.89	0.69	31.90	13.461
521	26000	-3.49	111.43	-111.43	-2.13	-2.79	0.81	10.81	9.62	-2.94	0.70	31.85	13.439
522	26050	-3.55	113.31	-113.31	-2.13	-2.93	0.81	11.21	9.98	-2.99	0.71	32.03	13.516
523	26100	-3.61	115.36	-115.36	-2.13	-3.07	0.81	11.68	10.41	-3.04	0.71	32.39	13.67
524	26150	-3.68	117.41	-117.41	-3.51	-3.21	0.81	12.22	10.89	-3.10	0.71	32.89	13.88
525	26200	-3.74	119.46	-119.46	-3.74	-3.36	0.81	12.81	11.41	-3.15	0.71	33.51	14.141
526	26250	-3.81	121.51	-121.51	-3.79	-3.50	0.81	13.45	11.98	-3.21	0.71	34.25	14.451
527	26300	-3.87	123.56	-123.56	-3.73	-3.64	0.81	14.12	12.57	-3.26	0.71	35.09	14.806
528	26350	-3.94	125.61	-125.61	-3.51	-3.78	0.80	14.83	13.20	-3.32	0.70	36.03	15.204

529	26400	-4.00	127.66	-127.66	-3.46	-3.93	0.80	15.56	13.86	-3.37	0.70	37.06	15.637
530	26450	-4.06	129.72	-129.72	-3.46	-4.07	0.79	16.32	14.53	-3.43	0.69	38.18	16.11
531	26500	-4.13	131.77	-131.77	-3.73	-4.21	0.79	17.10	15.23	-3.48	0.68	39.37	16.615
532	26550	-4.19	133.82	-133.82	-3.79	-4.35	0.79	17.90	15.94	-3.54	0.68	40.64	17.151
533	26600	-4.25	135.74	-135.74	-3.98	-4.43	0.79	17.79	15.84	-3.61	0.69	40.27	16.994
534	26650	-4.28	136.70	-136.70	-3.98	-4.44	0.80	17.43	15.52	-3.65	0.70	39.57	16.698
535	26700	-4.29	137.03	-137.03	-3.98	-4.42	0.81	17.00	15.14	-3.67	0.71	38.78	16.363
536	26750	-4.30	137.36	-137.36	-3.98	-4.41	0.81	16.57	14.76	-3.69	0.72	37.98	16.028
537	26800	-4.31	137.69	-137.69	-3.79	-4.39	0.82	16.14	14.38	-3.71	0.73	37.20	15.699
538	26850	-4.32	138.02	-138.02	-3.79	-4.37	0.83	15.72	14.00	-3.72	0.74	36.43	15.372
539	26900	-4.34	138.35	-138.35	-3.79	-4.35	0.83	15.29	13.62	-3.74	0.75	35.66	15.049
540	26950	-4.35	138.68	-138.68	-3.73	-4.33	0.84	14.99	13.35	-3.76	0.76	35.28	14.887
541	27000	-4.36	139.01	-139.01	-3.79	-4.28	0.84	14.83	13.21	-3.76	0.76	35.36	14.92
542	27050	-4.37	139.34	-139.34	-3.98	-4.24	0.84	14.69	13.08	-3.76	0.76	35.47	14.969
543	27100	-4.49	143.13	-143.13	-4.04	-4.35	0.84	14.88	13.26	-3.87	0.76	35.98	15.182
544	27150	-4.62	147.50	-147.50	-4.33	-4.49	0.85	15.14	13.48	-4.00	0.77	36.55	15.422
545	27200	-4.76	151.87	-151.87	-4.33	-4.63	0.85	15.39	13.71	-4.13	0.77	37.11	15.659
546	27250	-4.90	156.24	-156.24	-4.41	-4.77	0.85	15.64	13.93	-4.25	0.78	37.68	15.899
547	27300	-5.03	160.61	-160.61	-4.66	-4.91	0.86	15.90	14.16	-4.38	0.78	38.25	16.139
548	27350	-5.14	164.08	-164.08	-4.67	-5.01	0.86	16.06	14.31	-4.48	0.79	38.71	16.335
549	27400	-5.20	165.92	-165.92	-4.75	-5.04	0.86	16.07	14.31	-4.53	0.79	39.01	16.461
550	27450	-5.26	167.75	-167.75	-4.75	-5.07	0.86	16.08	14.32	-4.58	0.79	39.32	16.592
551	27500	-5.31	169.59	-169.59	-5.09	-5.09	0.86	16.09	14.33	-4.63	0.79	39.64	16.726

552	27550	-5.37	171.42	-171.42	-5.14	-5.12	0.86	16.11	14.35	-4.68	0.79	39.97	16.866
553	27600	-5.40	172.42	-172.42	-5.20	-5.13	0.86	16.12	14.36	-4.71	0.79	40.15	16.943
554	27650	-5.42	172.90	-172.90	-5.20	-5.14	0.86	16.13	14.37	-4.72	0.79	40.24	16.979
555	27700	-5.43	173.39	-173.39	-5.20	-5.15	0.86	16.14	14.37	-4.73	0.79	40.32	17.015
556	27750	-5.45	173.88	-173.88	-5.20	-5.15	0.86	16.14	14.38	-4.75	0.79	40.41	17.051
557	27800	-5.42	173.05	-173.05	-5.20	-5.10	0.86	16.03	14.28	-4.72	0.79	40.39	17.043
558	27850	-5.38	171.60	-171.60	-5.20	-5.02	0.86	15.90	14.16	-4.67	0.79	40.38	17.04
559	27900	-5.33	170.15	-170.15	-5.20	-4.95	0.86	15.88	14.15	-4.62	0.78	40.57	17.12
560	27950	-5.29	168.70	-168.70	-5.20	-4.88	0.85	15.91	14.17	-4.57	0.78	40.89	17.257
561	28000	-5.24	167.26	-167.26	-5.20	-4.80	0.85	16.00	14.25	-4.51	0.77	41.43	17.485
562	28050	-5.20	165.81	-165.81	-5.20	-4.72	0.84	16.10	14.34	-4.46	0.76	41.98	17.714
563	28100	-5.15	164.37	-164.37	-5.15	-4.64	0.84	16.20	14.43	-4.40	0.75	42.53	17.949
564	28150	-5.11	162.92	-162.92	-5.11	-4.56	0.83	16.30	14.52	-4.35	0.74	43.10	18.186
565	28200	-5.06	161.47	-161.47	-4.75	-4.49	0.82	16.41	14.61	-4.29	0.73	43.67	18.428
566	28250	-5.01	160.02	-160.02	-4.75	-4.41	0.82	16.52	14.71	-4.23	0.72	44.25	18.672
567	28300	-4.98	158.80	-158.80	-4.75	-4.34	0.81	16.65	14.83	-4.18	0.71	44.84	18.92
568	28350	-4.95	157.94	-157.94	-4.75	-4.29	0.80	16.80	14.97	-4.15	0.70	45.45	19.179
569	28400	-4.92	157.10	-157.10	-4.75	-4.24	0.80	16.94	15.08	-4.11	0.69	45.98	19.404
570	28450	-4.90	156.24	-156.24	-4.75	-4.19	0.79	17.01	15.15	-4.08	0.68	46.32	19.545
571	28500	-4.87	155.38	-155.38	-4.75	-4.15	0.79	17.07	15.21	-4.04	0.68	46.64	19.683
572	28550	-4.84	154.52	-154.52	-2.61	-4.09	0.78	17.06	15.19	-4.01	0.67	46.85	19.769
573	28600	-4.83	154.15	-154.15	-2.73	-4.03	0.78	16.65	14.83	-4.01	0.67	46.41	19.586
574	28650	-4.90	156.42	-156.42	-2.75	-4.09	0.79	16.42	14.62	-4.09	0.69	46.02	19.42

575	28700	-4.97	158.70	-158.70	-2.89	-4.14	0.80	16.19	14.42	-4.17	0.70	45.63	19.255
576	28750	-5.04	160.97	-160.97	-3.06	-4.20	0.81	15.96	14.21	-4.25	0.71	45.25	19.095
577	28800	-5.12	163.26	-163.26	-3.06	-4.25	0.82	15.73	14.01	-4.33	0.72	44.88	18.939
578	28850	-5.19	165.53	-165.53	-3.25	-4.31	0.83	15.51	13.82	-4.41	0.73	44.52	18.785
579	28900	-5.26	167.80	-167.80	-3.25	-4.36	0.83	15.29	13.62	-4.48	0.74	44.16	18.634
580	28950	-5.22	166.66	-166.66	-3.27	-4.37	0.84	14.89	13.26	-4.47	0.75	42.78	18.051
581	29000	-5.11	163.20	-163.20	-3.25	-4.35	0.85	14.46	12.87	-4.39	0.76	40.91	17.261
582	29050	-5.02	160.15	-160.15	-3.25	-4.34	0.85	14.19	12.64	-4.32	0.77	39.48	16.661
583	29100	-4.92	157.04	-157.04	-4.75	-4.34	0.86	13.96	12.43	-4.25	0.77	38.08	16.071
584	29150	-4.82	153.94	-153.94	-4.75	-4.33	0.86	13.74	12.24	-4.18	0.78	36.74	15.502
585	29200	-4.73	150.83	-150.83	-4.73	-4.31	0.86	13.52	12.05	-4.10	0.79	35.42	14.946
586	29250	-4.63	147.72	-147.72	-4.41	-4.30	0.87	13.34	11.88	-4.03	0.79	34.17	14.42
587	29300	-4.69	149.52	-149.52	-4.69	-4.35	0.87	13.34	11.88	-4.08	0.80	34.27	14.46
588	29350	-4.83	154.04	-154.04	-4.75	-4.40	0.86	13.79	12.28	-4.19	0.79	36.21	15.281
589	29400	-4.97	158.56	-158.56	-4.75	-4.44	0.86	14.28	12.71	-4.29	0.78	38.24	16.136
590	29450	-5.11	163.08	-163.08	-5.11	-4.52	0.86	14.44	12.86	-4.42	0.78	39.23	16.554
591	29500	-5.25	167.60	-167.60	-5.20	-4.74	0.87	14.49	12.91	-4.57	0.79	38.60	16.289
592	29550	-5.39	172.11	-172.11	-5.20	-4.99	0.87	15.01	13.36	-4.71	0.80	38.75	16.353
593	29600	-5.36	170.98	-170.98	-5.20	-4.99	0.87	15.09	13.44	-4.68	0.80	38.66	16.316
594	29650	-5.31	169.58	-169.58	-5.20	-4.97	0.87	15.16	13.50	-4.64	0.80	38.57	16.274
595	29700	-5.27	168.16	-168.16	-5.20	-4.95	0.87	15.23	13.57	-4.60	0.80	38.48	16.237
596	29750	-5.23	166.75	-166.75	-5.10	-4.94	0.87	15.31	13.63	-4.56	0.80	38.40	16.204
597	29800	-5.18	165.34	-165.34	-5.09	-4.92	0.86	15.39	13.70	-4.52	0.79	38.33	16.173

598	29850	-5.14	163.92	-163.92	-4.75	-4.90	0.86	15.47	13.78	-4.47	0.79	38.27	16.148
599	29900	-5.09	162.51	-162.51	-4.75	-4.89	0.86	15.55	13.85	-4.43	0.79	38.21	16.125
600	29950	-5.05	161.10	-161.10	-4.69	-4.87	0.86	15.63	13.92	-4.39	0.79	38.17	16.107
601	30000	-5.00	159.69	-159.69	-4.66	-4.85	0.86	15.73	14.01	-4.35	0.78	38.14	16.094
602	30050	-4.96	158.27	-158.27	-4.41	-4.83	0.85	15.82	14.09	-4.31	0.78	38.12	16.084
603	30100	-4.92	156.86	-156.86	-4.39	-4.82	0.85	15.91	14.17	-4.27	0.78	38.10	16.079
604	30150	-4.87	155.45	-155.45	-4.33	-4.78	0.84	16.25	14.47	-4.21	0.76	38.85	16.394
605	30200	-4.83	154.04	-154.04	-4.35	-4.70	0.84	16.06	14.30	-4.17	0.76	38.68	16.32
606	30250	-4.75	151.73	-151.73	-4.41	-4.56	0.85	15.33	13.65	-4.11	0.77	37.62	15.877
607	30300	-4.68	149.29	-149.29	-4.41	-4.40	0.85	14.61	13.01	-4.04	0.77	36.64	15.461
608	30350	-4.60	146.86	-146.86	-4.41	-4.25	0.85	13.93	12.41	-3.97	0.77	35.77	15.096
609	30400	-4.53	144.43	-144.43	-4.41	-4.10	0.85	13.33	11.87	-3.91	0.77	35.14	14.828
610	30450	-4.45	142.00	-142.00	-4.41	-3.94	0.86	12.78	11.38	-3.84	0.77	34.62	14.608
611	30500	-4.37	139.58	-139.58	-2.76	-3.78	0.86	12.28	10.93	-3.77	0.77	34.22	14.438
612	30550	-4.30	137.15	-137.15	-2.74	-3.63	0.85	11.83	10.54	-3.70	0.77	33.93	14.319
613	30600	-4.21	134.24	-134.24	-2.73	-3.47	0.85	11.42	10.17	-3.62	0.76	33.62	14.189
614	30650	-4.20	133.93	-133.93	-2.74	-3.45	0.86	11.16	9.94	-3.62	0.77	33.09	13.965
615	30700	-4.26	135.97	-135.97	-2.89	-3.54	0.86	11.05	9.85	-3.69	0.78	32.56	13.74
616	30750	-4.32	138.01	-138.01	-2.89	-3.64	0.87	10.95	9.75	-3.77	0.79	32.03	13.518
617	30800	-4.39	140.04	-140.04	-3.06	-3.73	0.88	10.85	9.67	-3.84	0.80	31.51	13.298
618	30850	-4.45	142.08	-142.08	-3.06	-3.83	0.89	10.76	9.58	-3.91	0.81	31.00	13.082
619	30900	-4.52	144.12	-144.12	-3.25	-3.92	0.89	10.66	9.50	-3.98	0.82	30.50	12.87
620	30950	-4.58	146.16	-146.16	-3.25	-4.02	0.90	10.58	9.42	-4.05	0.83	30.00	12.661

621	31000	-4.64	148.20	-148.20	-3.27	-4.11	0.90	10.50	9.35	-4.12	0.84	29.53	12.46
622	31050	-4.71	150.24	-150.24	-3.46	-4.20	0.91	10.31	9.18	-4.20	0.85	28.88	12.188
623	31100	-4.77	152.28	-152.28	-3.46	-4.27	0.92	10.03	8.93	-4.28	0.86	28.10	11.857
624	31150	-4.84	154.31	-154.31	-3.73	-4.35	0.93	9.75	8.68	-4.35	0.88	27.31	11.524
625	31200	-4.90	156.35	-156.35	-3.73	-4.43	0.93	9.47	8.43	-4.43	0.89	26.52	11.193
626	31250	-4.96	158.39	-158.39	-3.76	-4.51	0.94	9.18	8.18	-4.51	0.89	25.74	10.861
627	31300	-5.03	160.43	-160.43	-3.98	-4.58	0.94	8.90	7.93	-4.59	0.90	24.95	10.529
628	31350	-5.09	162.47	-162.47	-3.98	-4.66	0.95	8.62	7.68	-4.66	0.91	24.17	10.198
629	31400	-5.16	164.59	-164.59	-5.16	-4.74	0.95	8.34	7.43	-4.75	0.92	23.39	9.868
630	31450	-5.23	166.84	-166.84	-4.33	-4.83	0.96	8.07	7.19	-4.83	0.93	22.60	9.536
631	31500	-5.30	169.07	-169.07	-4.33	-4.92	0.96	7.80	6.95	-4.91	0.93	21.81	9.204
632	31550	-5.37	171.31	-171.31	-4.38	-5.00	0.96	7.53	6.71	-5.00	0.94	21.03	8.872
633	31600	-5.44	173.57	-173.57	-4.66	-5.09	0.97	7.26	6.47	-5.08	0.95	20.24	8.542
634	31650	-5.52	176.02	-176.02	-4.66	-5.18	0.97	7.00	6.24	-5.17	0.95	19.52	8.236
635	31700	-5.59	178.48	-178.48	-4.71	-5.27	0.97	6.74	6.00	-5.26	0.96	18.79	7.929
636	31750	-5.67	180.93	-180.93	-5.67	-5.36	0.98	6.48	5.77	-5.35	0.96	18.06	7.621
637	31800	-5.75	183.39	-183.39	-5.74	-5.45	0.98	6.22	5.54	-5.44	0.96	17.34	7.318
638	31850	-5.82	185.84	-185.84	-5.09	-5.54	0.98	5.96	5.31	-5.53	0.97	16.61	7.011
639	31900	-5.90	188.29	-188.29	-5.15	-5.63	0.98	5.70	5.08	-5.62	0.97	15.89	6.703
640	31950	-5.98	190.75	-190.75	-5.74	-5.72	0.99	5.44	4.85	-5.71	0.98	15.16	6.397
641	32000	-6.05	193.20	-193.20	-5.61	-5.81	0.99	5.18	4.61	-5.80	0.98	14.43	6.09
642	32050	-6.13	195.66	-195.66	-5.61	-5.90	0.99	4.92	4.38	-5.89	0.98	13.70	5.783
643	32100	-6.21	198.11	-198.11	-5.61	-5.99	0.99	4.76	4.24	-5.98	0.98	13.13	5.541

644	32150	-6.21	198.06	-198.06	-5.62	-5.98	0.99	4.49	4.00	-5.98	0.98	12.60	5.319
645	32200	-6.18	197.23	-197.23	-5.63	-5.93	0.99	4.19	3.74	-5.97	0.99	12.12	5.112
646	32250	-6.15	196.41	-196.41	-5.64	-5.89	0.99	3.92	3.49	-5.95	0.99	11.67	4.923
647	32300	-6.13	195.58	-195.58	-5.70	-5.84	0.99	3.68	3.28	-5.94	0.99	11.27	4.756
648	32350	-6.10	194.75	-194.75	-5.74	-5.79	0.99	3.48	3.10	-5.92	0.99	10.93	4.614
649	32400	-6.08	193.93	-193.93	-5.74	-5.75	0.99	3.31	2.95	-5.90	0.99	10.66	4.499
650	32450	-6.05	193.11	-193.11	-5.74	-5.70	0.99	3.20	2.85	-5.89	0.99	10.46	4.412
651	32500	-6.03	192.28	-192.28	-5.74	-5.65	1.00	3.14	2.80	-5.87	0.99	10.32	4.355
652	32550	-6.00	191.45	-191.45	-5.73	-5.61	0.99	3.14	2.80	-5.86	0.99	10.27	4.333
653	32600	-5.97	190.63	-190.63	-5.73	-5.56	0.99	3.20	2.85	-5.84	0.99	10.28	4.34
654	32650	-5.95	189.80	-189.80	-5.74	-5.51	0.99	3.31	2.95	-5.82	0.99	10.38	4.379
655	32700	-5.92	188.97	-188.97	-5.74	-5.47	0.99	3.47	3.09	-5.81	0.99	10.55	4.45
656	32750	-5.90	188.16	-188.16	-5.74	-5.42	0.99	3.67	3.27	-5.79	0.99	10.78	4.548
657	32800	-5.88	187.63	-187.63	-5.74	-5.39	0.99	3.88	3.45	-5.79	0.99	11.00	4.644
658	32850	-5.86	187.10	-187.10	-5.74	-5.35	0.99	4.13	3.68	-5.78	0.99	11.32	4.777
659	32900	-5.85	186.58	-186.58	-5.74	-5.32	0.99	4.41	3.93	-5.77	0.99	11.69	4.934
660	32950	-5.83	186.05	-186.05	-5.74	-5.28	0.99	4.72	4.21	-5.77	0.98	12.13	5.118
661	33000	-5.81	185.52	-185.52	-5.69	-5.24	0.99	5.04	4.49	-5.76	0.98	12.60	5.319
662	33050	-5.80	184.99	-184.99	-5.61	-5.21	0.98	5.38	4.79	-5.76	0.98	13.12	5.538
663	33100	-5.78	184.46	-184.46	-5.61	-5.17	0.98	5.73	5.10	-5.75	0.98	13.68	5.773
664	33150	-5.76	183.93	-183.93	-5.61	-5.14	0.98	6.09	5.42	-5.74	0.98	14.27	6.024
665	33200	-5.75	183.40	-183.40	-5.61	-5.10	0.97	6.45	5.75	-5.74	0.98	14.89	6.285
666	33250	-5.73	182.89	-182.89	-5.61	-5.07	0.97	6.83	6.08	-5.73	0.97	15.54	6.557

667	33300	-5.71	182.36	-182.36	-5.20	-5.03	0.97	7.21	6.42	-5.73	0.97	16.21	6.839
668	33350	-5.70	181.83	-181.83	-5.20	-5.00	0.96	7.59	6.76	-5.72	0.97	16.90	7.132
669	33400	-5.67	180.84	-180.84	-5.20	-4.95	0.96	7.93	7.07	-5.70	0.97	17.47	7.372
670	33450	-5.62	179.39	-179.39	-5.20	-4.91	0.96	8.24	7.34	-5.67	0.97	17.93	7.566
671	33500	-5.58	177.94	-177.94	-5.20	-4.86	0.95	8.55	7.62	-5.64	0.96	18.42	7.774
672	33550	-5.53	176.49	-176.49	-5.15	-4.81	0.95	8.87	7.90	-5.61	0.96	18.95	7.997
673	33600	-5.49	175.04	-175.04	-5.74	-4.76	0.94	9.19	8.19	-5.58	0.96	19.50	8.228
674	33650	-5.44	173.59	-173.59	-5.74	-4.72	0.94	9.52	8.48	-5.55	0.95	20.08	8.472
675	33700	-5.39	172.14	-172.14	-5.74	-4.67	0.93	9.86	8.78	-5.52	0.95	20.68	8.726
676	33750	-5.35	170.69	-170.69	-5.74	-4.62	0.93	10.20	9.08	-5.49	0.95	21.31	8.991
677	33800	-5.33	170.19	-170.19	-5.74	-4.62	0.92	10.40	9.27	-5.49	0.95	21.65	9.137
678	33850	-5.34	170.52	-170.52	-5.74	-4.62	0.92	10.37	9.24	-5.49	0.95	21.61	9.117
679	33900	-5.35	170.85	-170.85	-5.74	-4.63	0.93	10.32	9.19	-5.50	0.95	21.53	9.083
680	33950	-5.36	171.19	-171.19	-5.74	-4.63	0.93	10.26	9.14	-5.50	0.95	21.43	9.045
681	34000	-5.37	171.52	-171.52	-5.74	-4.64	0.93	10.20	9.09	-5.51	0.95	21.35	9.009
682	34050	-5.39	171.86	-171.86	-5.74	-4.64	0.93	10.14	9.03	-5.52	0.95	21.26	8.973
683	34100	-5.40	172.20	-172.20	-5.74	-4.65	0.93	10.09	8.98	-5.52	0.95	21.18	8.939
684	34150	-5.41	172.53	-172.53	-5.74	-4.65	0.93	10.03	8.93	-5.53	0.95	21.11	8.907
685	34200	-5.42	172.86	-172.86	-5.74	-4.66	0.93	9.97	8.88	-5.53	0.95	21.03	8.873
686	34250	-5.43	173.19	-173.19	-5.74	-4.66	0.93	9.92	8.83	-5.54	0.95	20.96	8.845
687	34300	-5.44	173.53	-173.53	-5.74	-4.67	0.93	9.86	8.78	-5.54	0.95	20.90	8.817
688	34350	-5.45	173.87	-173.87	-5.74	-4.67	0.93	9.81	8.74	-5.55	0.95	20.83	8.791
689	34400	-5.46	174.20	-174.20	-5.74	-4.68	0.93	9.76	8.69	-5.55	0.95	20.78	8.768

690	34450	-5.47	174.54	-174.54	-5.74	-4.68	0.94	9.71	8.64	-5.56	0.95	20.73	8.746
691	34500	-5.48	174.87	-174.87	-5.74	-4.69	0.94	9.65	8.60	-5.56	0.95	20.67	8.721
692	34550	-5.49	175.20	-175.20	-5.09	-4.69	0.94	9.60	8.55	-5.57	0.95	20.63	8.704
693	34600	-5.50	175.54	-175.54	-5.09	-4.69	0.94	9.68	8.62	-5.58	0.95	20.84	8.793
694	34650	-5.51	175.88	-175.88	-5.09	-4.69	0.93	9.84	8.77	-5.59	0.95	21.21	8.952
695	34700	-5.52	176.21	-176.21	-5.09	-4.68	0.93	10.00	8.91	-5.60	0.95	21.59	9.11
696	34750	-5.53	176.55	-176.55	-5.10	-4.67	0.93	10.16	9.05	-5.60	0.95	21.97	9.27
697	34800	-5.55	177.11	-177.11	-5.11	-4.67	0.93	10.29	9.17	-5.62	0.95	22.27	9.396
698	34850	-5.57	177.77	-177.77	-5.12	-4.68	0.93	10.40	9.27	-5.64	0.95	22.53	9.509
699	34900	-5.59	178.42	-178.42	-5.14	-4.69	0.93	10.52	9.37	-5.66	0.94	22.81	9.626
700	34950	-5.61	179.08	-179.08	-5.15	-4.70	0.92	10.63	9.47	-5.68	0.94	23.09	9.742
701	35000	-5.63	179.74	-179.74	-6.24	-4.70	0.92	10.75	9.57	-5.70	0.94	23.36	9.856
702	35050	-5.65	180.40	-180.40	-6.24	-4.71	0.92	10.86	9.67	-5.72	0.94	23.63	9.972
703	35100	-5.67	181.04	-181.04	-6.24	-4.72	0.92	10.98	9.78	-5.74	0.94	23.91	10.089
704	35150	-5.69	181.70	-181.70	-6.25	-4.73	0.92	11.09	9.88	-5.76	0.94	24.18	10.203
705	35200	-5.71	182.36	-182.36	-6.28	-4.73	0.92	11.20	9.98	-5.78	0.94	24.46	10.32
706	35250	-5.70	181.84	-181.84	-6.26	-4.73	0.92	11.21	9.98	-5.77	0.94	24.40	10.296
707	35300	-5.68	181.27	-181.27	-6.25	-4.71	0.92	11.24	10.01	-5.75	0.94	24.40	10.295
708	35350	-5.66	180.70	-180.70	-6.24	-4.70	0.91	11.39	10.14	-5.74	0.94	24.62	10.388
709	35400	-5.64	180.13	-180.13	-6.24	-4.68	0.91	11.54	10.28	-5.73	0.94	24.85	10.486
710	35450	-5.63	179.55	-179.55	-6.24	-4.66	0.91	11.69	10.41	-5.72	0.94	25.08	10.585
711	35500	-5.61	178.98	-178.98	-6.24	-4.64	0.91	11.84	10.54	-5.71	0.93	25.32	10.686
712	35550	-5.59	178.41	-178.41	-6.24	-4.63	0.90	11.99	10.68	-5.70	0.93	25.57	10.789

713	35600	-5.60	178.68	-178.68	-6.24	-4.65	0.90	12.02	10.70	-5.72	0.93	25.54	10.779
714	35650	-5.73	182.70	-182.70	-6.29	-4.84	0.92	11.50	10.24	-5.85	0.94	24.31	10.258
715	35700	-5.85	186.73	-186.73	-6.39	-5.03	0.93	10.98	9.78	-5.98	0.95	23.10	9.747
716	35750	-5.98	190.76	-190.76	-6.39	-5.22	0.94	10.47	9.32	-6.11	0.96	21.92	9.249
717	35800	-6.10	194.79	-194.79	-6.39	-5.41	0.95	9.96	8.87	-6.25	0.96	20.76	8.761
718	35850	-6.23	198.82	-198.82	-6.39	-5.60	0.96	9.46	8.43	-6.38	0.97	19.64	8.287
719	35900	-6.36	202.85	-202.85	-7.02	-5.79	0.96	8.97	7.99	-6.51	0.97	18.56	7.831
720	35950	-6.48	206.88	-206.88	-7.02	-5.97	0.97	8.69	7.74	-6.65	0.97	17.94	7.571
721	36000	-6.61	210.91	-210.91	-7.08	-6.14	0.97	8.55	7.61	-6.79	0.98	17.65	7.446
722	36050	-6.74	214.94	-214.94	-7.22	-6.31	0.97	8.42	7.50	-6.92	0.98	17.41	7.349
723	36100	-6.86	218.97	-218.97	-7.22	-6.48	0.97	8.30	7.39	-7.06	0.98	17.24	7.275
724	36150	-6.99	223.00	-223.00	-7.02	-6.65	0.98	8.19	7.30	-7.20	0.98	17.13	7.231
725	36200	-7.11	227.03	-227.03	-7.12	-6.82	0.98	8.10	7.22	-7.34	0.98	17.10	7.216
726	36250	-7.24	231.06	-231.06	-7.22	-7.00	0.98	8.02	7.15	-7.48	0.98	17.12	7.226
727	36300	-7.37	235.09	-235.09	-8.22	-7.17	0.98	7.96	7.09	-7.62	0.98	17.22	7.267
728	36350	-7.49	239.11	-239.11	-8.36	-7.34	0.98	7.91	7.05	-7.76	0.98	17.39	7.337
729	36400	-7.62	243.14	-243.14	-8.14	-7.51	0.98	7.88	7.01	-7.90	0.98	17.61	7.43
730	36450	-7.66	244.29	-244.29	-8.14	-7.55	0.98	8.18	7.29	-7.95	0.98	18.36	7.748
731	36500	-7.69	245.47	-245.47	-8.14	-7.59	0.98	8.50	7.57	-8.00	0.98	19.12	8.069
732	36550	-7.74	247.00	-247.00	-8.14	-7.63	0.98	8.83	7.87	-8.05	0.98	19.85	8.377
733	36600	-7.79	248.53	-248.53	-8.14	-7.68	0.98	9.16	8.16	-8.11	0.98	20.58	8.685
734	36650	-7.84	250.06	-250.06	-8.14	-7.69	0.97	9.88	8.80	-8.18	0.97	22.04	9.301
735	36700	-7.88	251.58	-251.58	-8.14	-7.66	0.97	11.44	10.19	-8.27	0.97	25.16	10.616

736	36750	-7.93	253.11	-253.11	-8.14	-7.63	0.96	13.02	11.60	-8.35	0.96	28.32	11.952
737	36800	-7.98	254.64	-254.64	-8.14	-7.60	0.94	14.61	13.01	-8.44	0.95	31.53	13.306
738	36850	-8.03	256.17	-256.17	-8.14	-7.57	0.93	16.21	14.44	-8.52	0.94	34.77	14.671
739	36900	-8.07	257.69	-257.69	-8.14	-7.54	0.92	17.81	15.86	-8.61	0.93	38.02	16.043
740	36950	-8.12	259.22	-259.22	-8.14	-7.54	0.91	18.78	16.73	-8.68	0.93	40.03	16.892
741	37000	-8.17	260.75	-260.75	-8.17	-7.64	0.92	18.18	16.19	-8.72	0.93	38.91	16.419
742	37050	-8.22	262.28	-262.28	-8.22	-7.73	0.92	17.59	15.67	-8.76	0.94	37.81	15.955
743	37100	-8.27	263.81	-263.81	-8.27	-7.83	0.93	17.00	15.14	-8.80	0.94	36.72	15.496
744	37150	-8.31	265.33	-265.33	-8.31	-7.93	0.94	16.42	14.63	-8.84	0.94	35.66	15.048
745	37200	-8.36	266.86	-266.86	-8.36	-8.02	0.94	15.84	14.11	-8.88	0.95	34.61	14.606
746	37250	-8.41	268.38	-268.38	-8.40	-8.12	0.95	15.27	13.60	-8.92	0.95	33.59	14.174
747	37300	-8.46	269.91	-269.91	-8.40	-8.21	0.95	14.70	13.09	-8.96	0.95	32.59	13.752
748	37350	-8.51	271.44	-271.44	-8.40	-8.31	0.96	14.14	12.59	-9.00	0.96	31.61	13.338
749	37400	-8.61	274.77	-274.77	-9.34	-8.49	0.96	13.38	11.92	-9.10	0.96	30.38	12.819
750	37450	-8.72	278.33	-278.33	-9.34	-8.68	0.97	12.62	11.24	-9.20	0.96	29.18	12.314
751	37500	-8.83	281.89	-281.89	-9.34	-8.86	0.97	11.88	10.58	-9.31	0.97	28.08	11.85
752	37550	-8.94	285.45	-285.45	-9.34	-9.05	0.98	11.17	9.95	-9.41	0.97	27.08	11.429
753	37600	-9.06	289.01	-289.01	-9.34	-9.24	0.98	10.50	9.35	-9.51	0.97	26.21	11.06
754	37650	-9.17	292.57	-292.57	-9.34	-9.43	0.98	9.87	8.79	-9.61	0.98	25.46	10.742
755	37700	-9.28	296.13	-296.13	-9.34	-9.62	0.99	9.29	8.27	-9.72	0.98	24.84	10.484
756	37750	-9.39	299.69	-299.69	-9.39	-9.87	0.99	8.05	7.17	-9.80	0.98	23.30	9.831
757	37800	-9.50	303.24	-303.24	-9.70	-10.21	0.99	6.72	5.99	-9.85	0.98	21.83	9.213
758	37850	-9.61	306.80	-306.80	-9.34	-10.55	0.99	7.16	6.38	-9.90	0.98	22.81	9.627

759	37900	-9.73	310.36	-310.36	-9.38	-10.89	0.99	9.11	8.12	-9.95	0.98	25.97	10.96
760	37950	-9.84	313.92	-313.92	-9.70	-11.23	0.98	11.86	10.56	-10.00	0.97	30.64	12.931
761	38000	-9.95	317.48	-317.48	-9.70	-11.51	0.96	21.14	142.56	-9.79	0.96	46.66	131.263

Appendix 4: Ethical clearance

UNIVERSITY OF GHANA

ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES (ECBAS)

P. O. Box LG 1195, Legon-Accra

Ref. No: ECBAS 016/18-19

10th January 2019.

Mr. Stephen Babson
Institute of Environment & Sanitation Studies
University of Ghana
Legon, Accra

Dear Mr. Babson,

ECBAS 016/18-19: EXPLORING THE INTERLINKAGES BEWEEN COASTAL ENVIRONMENTAL CHANGE AND CULTURAL ECOSYSTEM SERVICES IN ADA, GHANA

This is to inform you that the above referenced study has been presented to the Ethics Committee for Basic and Applied Sciences for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	09/01/2020
On Agenda for:	Initial Submission
Date of Submission:	06/11/2018
ECBAS Action:	Approved
Reporting:	Quarterly

Please accept my congratulations.

Yours sincerely,

Professor Daniel Bruce Sarpong
ECBAS Chairperson

ETHICS COMMITTEE FOR BASIC AND APPLIED SCIENCES
APPROVED
10 JAN 2019
UNIVERSITY OF GHANA

IP No.: 3014

Email:ethicscbas@ug.edu.gh